1st European Immersive Education Summit

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Conference Proceedings

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1st European Immersive Education Summit

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Preface from the editors

What you are holding in your hands is the proceedings of the *1st European Immersive Education Summit*. It was hold at the Universidad Carlos III de Madrid in Leganés (Madrid, Spain) on 28 and 29 November 2011. This is the first Summit organized by the European Chapter of the Immersive Education Initiative and follows the tradition of many other Summits mainly organized in Boston, MA, USA, but once also in Europe, in London in 2009. These summits bring together academia and industry to provide the latest innovations around 3D virtual worlds for education.

To put together this programme an international Programme Committee was created with many experts from all around the world. Following the Call for Papers 36 submissions were received, which were reviewed by three reviewers on quality and appropriateness. The 16 best papers were accepted either as full or as short papers for presentation at the summit and inclusion in the proceedings. For handling the organization of submitted papers, the handy Easychair system was used. Apart from the paper presentations, the programme also includes poster presentations and practical demos showing tools in action. Four keynotes represented a highlight in the program covering issues from the psychology of immersive environments to new pedagogies and technologies enabled by virtual worlds. Two in-world sessions were a living example of the use of 3D virtual worlds for education. Both were organized from Boston using Open Wonderland as supporting platform. One was a panel session where several members of this platform presented their projects and the other one was a hands-on workshop on how to build an Open Wonderland world. Finally, a panel session with representatives from academia and industry in Spain was devoted to reflect about the future of 3D worlds in education. This panel session was held in Spanish and organized by the eMadrid network and the TELSpain initiative. All these activities comprise altogether a varied and thought-provoking programme.

As editors of these proceedings and main organizers of the Summit, we would like to thank the international Programme Committee members for doing an excellent job reviewing the papers, the local Organizing Committee for handling all the organizational issues that make a difference in the end, the Universidad Carlos III de Madrid for providing the basic infrastructure, the eMadrid excellence network and the TELSpain association for their support, and last but by no means least the Immersive Education Initiative and in particular its European Chapter for providing the support and encouragement to organize this event.

Leganés (Madrid, Spain), November 2011

Carlos Delgado Kloos
Jose Jesus García Rueda
María Blanca Ibáñez Espiga
(Editors)

Preface from Aaron E. Walsh

The 1st European Immersive Education Summit, organized by the European Chapter of Immersive Education ("iED Europe") and graciously hosted by Universidad Carlos III, marks a major milestone in the growth and evolution of Immersive Education. In the six year history of Summits the 2011 European Summit was the first to be organized and run entirely by an official Chapter of the Immersive Education Initiative, and will also be the first iED Summit to have proceedings published in the inaugural issue of the Journal of Immersive Education (JiED) -- the first and only publication of record for the Immersive Education Initiative.

The Immersive Education Initiative was formed in 2005 as a non-profit international collaboration of universities, colleges, research institutes, museums, consortia and companies chartered to define and develop freely available open standards, best practices, platforms, and communities of support for virtual worlds, virtual reality, augmented reality, simulations and game-based learning and training systems. By 2010, with thousands of members worldwide (who together represent millions of students and learners) and growing, it was clear that such rapid and continued growth would be best supported if fostered through local and regional Chapters.

In early 2011 the very first iED Chapters began to take shape, with Dr. Michael Gardner (University of Essex, England) leading the effort to form the European Chapter. The European Chapter was subsequently launched on opening day of the 2011 Boston Summit, making iED Europe one of only three official iED Chapters in the world and the first one outside of the United States.

Immediately after being formed the European Chapter Board of Governors focused their attention on establishing an annual conference in Europe, and shortly thereafter issued a call for the 1st European Immersive Education Summit. Board member Dr. Carlos Delgado Kloos kindly arranged for his university to host the conference, and also handled the considerable logistics that ultimately enabled our community to convene from November 28-29 at Universidad Carlos III for the Summit.

A robust international response to the relatively short call period, and the breadth and depth of the papers that comprise the Summit proceedings, is testimony to the combined efforts of the European Chapter's Board of Governors and the European Summit organizing committee.

It is my personal and professional pleasure to congratulate the European Chapter of Immersive Education on the success of their first annual Summit, from which the proceedings are now available. Comprised of peer-reviewed papers and presentations written by leading experts from 12 countries, the 1st European Summit proceedings enrich our global community of researchers and practitioners by providing us with a deeper understanding of what's possible today as well as a glimpse into the future of immersive learning and teaching technologies, pedagogical theories and techniques, relevant standards and best practices.

Aaron E. Walsh
(Chair of the Board of Governors of the Immersive Education Innitiative)

Preface from Michael Gardner

It is with pleasure that I have this opportunity to introduce you to the Proceedings of the 1st Immersive Education Summit, which was held at Universidad Carlos III in Madrid on 28th and 29th November 2011. These proceedings contain both the short and long papers that were presented at the summit. Many people have been involved in the preparation of these proceedings which started with the launch of the European chapter of the Immersive Education Initiative at the Boston summit in May 2011. From the start, we felt it was vitally important that the new European Chapter acted as a hub for the wide-ranging and diverse European community. The European Summit was the ideal way of engaging with this community. It was seen as not only a good way of positioning the European Chapter as the premier forum for the discussion of innovation and research in the field of Immersive Education, but also a good way of establishing our own identity. There was not a lot of time between the launch of the European Chapter and the plan to run this first summit. I particularly would like to give my thanks to the hard work of the summit organising committee which has led to such a successful first event. The proceedings contain an array of high-quality reviewed papers from leading members of the Immersive Education community (12 countries), everything from underlying pedagogical theories through to the latest developments in virtual world technologies. We hope that the papers contained in these Proceedings will prove helpful toward developing the field of Immersive Education, and be of benefit to practitioners, researchers and developers alike.

Michael Gardner
(Chair of the Board of Governors of the European Chapter of the Immersive Education Innitiative)

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Workshops

Keynotes

The Psychology of Immersive Environments

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Abstract. In this keynote the mission of the Immersive Education Initiative's Psychology of Immersive Environments Technology Working Group (PIE.TWG) will be discussed as well as the results of group's recent call for "psychologically beneficial immersive environments." Examples include virtual hallucination simulators, virtual psychological counseling systems, phobia treatment applications, and a range of other psychologically beneficial immersive environments. The results of this call and related PIE.TWG activities will establish a searchable repository of psychologically beneficial virtual worlds, simulations, video games, mixed/augmented reality applications in addition to leading papers, case studies, and research in the field.

Keywords. Psychology of Immersive Environments, virtual hallucination simulators, virtual psychological counseling systems, phobia treatment applications.

A new generation of Virtual Worlds pedagogy and technology – RealXtend Tundra

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Abstract. The traditional notion of a learning environment has expanded from physical future learning environments to cover virtual spaces, which have become more common during the last years. Today, these extremely popular virtual learning environments have turned into virtual schools and towards 3D learning spaces accessible to all students. The 3D learning environment provides a richer learning experience when compared to the real life learning situation.

These considerations have inspired to the development work to produce a 3D virtual learning environment with the aim of providing a space for learning activities. World has changed, learning has changed and the learner has changed accordingly. Work culture has undergone a rapid transformation. The aim in this presentation is to draw a framework through stories about this change process facing the real world, local school and community of learners.

3D virtual worlds have been studied for a number of years as an e-learning environment, primarily by higher education. More studies from usability and user experience point of views need to be carried out in order to improve the interaction with 3D spaces and learning objects. Researchers and developers of virtual worlds must put their forces together in order to explore the requirements for extendable virtual worlds.

RealXtend is a great example of a non-profit open source virtual world platform, the goal of which is to advance the immersive web by creating and participating in the creation of technologies that enable rich interaction in virtual environments. The results of the project are licensed so that everyone can use and develop them further. The licensing is designed to maximize the usefulness and development potential of the system, specifically ensuring that it becomes a viable platform for business applications. In the presentation the ecosystem of virtual worlds will be highlighted and presented through examples.

When the virtual learning environment acts as an extension of the school and provides open interfaces to teaching activities, where the environment itself can be dynamically configured. Virtual school can be a great place for group and collaborative learning where students can interact easily with other people from different contexts, ages and cultures. The result of the development work will be the learning environment, in where individuals and teams in different contexts, learning environments, exploiting new technologies, can develop their excellence at the best possible way.

Keywords. 3D virtual worlds, 3D learning spaces, RealXtend.

Implementing Mixed Immersive Reality Teaching and Learning in Environments: Lessons Learned

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Abstract. Mixed Immersive Reality Teaching and Learning Environments [MiRTLE] facilities appear to have several practical advantages that can accelerate the rate of adoption of immersive synchronous platforms in higher education.

This technology which was developed by Dr. Michael Gardner and others [1] at the University of Essex in collaboration with Sun Microsystems has been adopted and implemented at various educational and business locations around the globe.

The largest such facility is located at Saint Paul College in the United States. This presentation will review the design, implementation and integration of the MiRTLE platform into coursework conducted at the college.

The cost, benefits, directions for applied research and the occasionally comic class room implications of conducting college level courses on the platform will be discussed. An assessment of the efficacy of the platform in applied settings will be presented.

A comparative study of relative merit to higher education of virtual world platforms that is currently underway at the college will be discussed.

[1] Bernard Horan, Michael Gardner, John Scott, "MiRTLE: A Mixed Reality Teaching & Learning Environment", Sun Microsystems Laboratories, 2009

Keywords. MiRTLE, virtual world platforms, higher education.

Inside Immersive Education and the Immersive Education Initiative

Aaron E. Walsh
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Abstract. The keynote will give attendees an insider's look at Immersive Education and the global Initiative that is responsible for defining and developing open standards, best practices, platforms, and communities of support for a wide range of virtual worlds, learning games, simulations and virtual reality applications designed specifically for teaching and training.

At the conclusion of the keynote it will announced that the Initiative's new Journal of Immersive Education (JiED) and the newly formed Full, Augmented and Mixed Reality Technology Group (FAM.TWG) both officially launch at the 1st European Immersive Education Summit (iED Summit).

Keywords. Immersive Education Initiative, virtual worlds, learning games, simulations, virtual reality applications.

Papers

The Development of a User-Friendly Authoring Tool (OPAL) used by Teachers and Students in Schools to Create User-Generated Contexts for Learning in a Virtual World Setting

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Abstract. This paper outlines the development and initial use of a user-friendly authoring tool (OPAL) developed in partnership between Daden Ltd, Academy 360, Sunderland, and the University of Hull, to enable teachers and students to develop their own props and actors ('e-Drama') to populate bespoke scenarios which are then ported into a suitable virtual world environment. It will describe the processes involved in authoring the scenarios.

Keywords. OPAL, virtual world, teachers, schools, pedagogy, KTP

Introduction

This paper will outline and illustrate an approach that addresses the following themes of the conference: '*Virtual and Mixed-Reality for Education*' and '*Pedagogy for the Internet Age*'. It explores the work of a partnership formed between a school (Academy 360 in Sunderland, UK), a commercial software company (Daden Ltd, Birmingham) and staff working in the University of Hull working through the mechanism of a Knowledge Transfer Partnership project (KTP) with the Academy, focused on the development of virtual world scenarios for learning.

The paper explores the rationale for, and development of, a user-friendly authoring tool (OPAL) developed in partnership between Daden Ltd and Academy 360. This enables users (in this instance teachers and students) to develop their own scenarios in a form of e-Drama in a 2-D world which can then be easily ported into a suitable virtual world environment [1]. Based on the work and experience previously undertaken with the PIVOTE tool (http://www.daden.co.uk/pivote.html) Daden have developed an authoring platform called OPAL which enables users, with limited technical ability or skill, to generate their own scenarios from a selection of templates which can then be populated with 3-D assets such as avatars, BOTS and other objects. This entire process is undertaken off-line and outside of the virtual world environment enabling users to work with relatively limited bandwidth, and due to its 'drag and drop' interface, relatively few technical skills, therefore being ideal for the situation which many schools and teachers face in respect to accessing virtual environments on site. All of the logic and scripting which are usually located in world are abstracted in XML format making the process more user-friendly and substantially more flexible. The solution enables users to rapidly change and relocate their scenarios in different virtual worlds, presenting teachers and students with varied pedagogical opportunities.

The paper will outline the technical problems and solutions associated with this development, and will concentrate on the extent to which this tool can support the creation of user-generated contexts for learning in virtual worlds. Using a socio-cultural theoretical perspective it will explore the extent to which the authoring tool and the resultant scenarios can scaffold user learning [2] enabling learners to move from one zone of development to the next without the direct intervention of a traditional mediation (i.e. a teacher).

Learning Affordances and Challenges in 3D Virtual Worlds

The learning affordances of 3D virtual environments are well documented, with particular emphasis being placed on 'representational fidelity', 'participant interactivity', enhanced opportunities for experiential and collaborative learning, and increases in motivation and learner engagement [3].
Specifically research has demonstrated that 'Virtual worlds…present an ideal platform for the engagement of learners in constructivist-focused educational practice' [4]. Further, 'virtual worlds can provide excellent settings for problem based learning (PBL) as they offer tools for the creation of simulated problems for a number of different disciplines' [4].

An example problem solving scenarios in virtual worlds for learning is a project Daden have recently delivered in training for New York City's Office of Emergency Management in running a hurricane shelter - a prescient development given the onset of Hurricane Irene twelve months later![5]. The training was rolled out at the start of 2011 with a total of 14 participants taking part. Responses in the subsequent programme evaluation were overwhelmingly positive as illustrated in the responses below:

- Did the program make you more confident in participating in the coastal storm plan sheltering system? - 86% answered positively.
- Did the program include training activities that were effective? - 86% answered positively.
- Did the program provide training in Hurricane Shelter activities that were closer to real world activities than classroom based courses? - 100% answered positively.

- Did the program engage you as a learner? 100% answered positively.

The ratings for the last two items are significantly higher than those for comparable online course formats which are typically delivered through a 1.5 hour Flash based tutorial. Indeed, when informally polled at the end of the course whether they would take the course again if given the chance, an overwhelming majority agreed they would.

However despite evidence of this nature in the vocational sector, and support for this kind of learning in aspects of Higher Education, the compulsory school sector in the UK has remained resistant to these trends and there are limited examples of schools using virtual worlds for mainstream teaching and learning. Indeed, there is limited empirical data to suggest schools and teachers are ready for such approaches considering the problems associated with implementation, maintenance and security and e-safety.

Some of the challenges relate to e-safety and the perceived dangers of using 3D environments, such as Second Life (SL), with adolescents, but there remain comparable technical and pedagogical challenges which have also limited the effective use of virtual worlds in compulsory school settings. These include:

1. The relative complexity associated with the creation of educational simulations in virtual worlds.
2. The difficulty of locating and relocating particular scripts in world and the problems associated with the maintenance of such environments.
3. The problems associated with the transfer of entire scenes and scenarios from one virtual platform to another.
4. The requirement for users to have constant access to high quality broadband connectivity for the creation and experience of virtual environments.
5. The difficulties and uncertainties faced by teachers in transferring or modifying their existing pedagogical patterns for use in a 3D environment.

These challenges have deterred many teachers in schools from implementing or experimenting with virtual world for the purposes of training and simulations, despite an emerging and persuasive body of research - largely from other sectors or phases - to indicate their educational value [6]. All but a handful of determined, resourceful and skilful practitioners have previously ventured into the creation of their own pedagogical scenarios within worlds such as SL and therefore it is unlikely many students have experienced the collaborative process of constructing their own world contexts, which this project and paper documents.

OPAL and PIVOTE Development

OPAL has developed from Daden's work in creating virtual world learning exercises over the last five years, and in particular from the PIVOTE product that was created as part of the JISC Problem Based learning in Virtual Worlds (PREVIEW) project. Before PIVOTE, the standard way of creating learning exercises in the SL virtual world was to embed scripts written in Linden Scripting Language in the in-world objects. Text was either embedded in the scripts, or placed in "notecards" which were also embedded in the objects. This approach required a relatively high technical skill level, made maintenance problematic since to change a piece of text or behaviour involved locating the relevant object in-world in order to make the change. This had the effect of making exercises and scenarios bespoke and unique to particular 3D platforms.

In developing a paramedic training system for St George's Hospital, London [7], Daden were introduced to Medbiquitous Virtual Patient (MVP) [7], an XML (Extensible Mark-up Language) standard created to enable medical schools across the globe to share "virtual patients" - simple training exercises for medical professionals based around a medical case and usually following a "branching" or "string-of-pearls" structure. It was realised that the MVP standard could also be used to define a virtual world training exercise, allowing the exercise to be defined and maintained in MVP XML through a readily accessible and manageable web interface, but with the user experiencing the exercise within the virtual world by interacting with in-world objects and people. With this approach the scripts in world could be kept far more generic – and effectively just passed as an object ID and a user action (e.g. chest – touched) back to the MVP "player" to work out the relevant response and pass that information back in-world. In this way all structure, logic and non-3D content of the exercise was kept in a manageable form on the web as MVP XML, and the bespoke in-world content was kept to a minimum. Added advantages of this approach was that every student action was automatically detected and could be easily time stamped logged, and the exercise could potentially be played from an environment other than the virtual world – such as the web.

The new MVP based system was called PIVOTE [8]. The MVP player, which manages the student interaction during an exercise, is written as a web-service. This allows any client environment to be potentially used as a PIVOTE front-end, from HTML (Hyper Text Mark-up Language) and Flash to mobiles. The value of PIVOTE as an authoring tool are numerous and include:

- *Maintenance and scalability*: the exercises are created online rather than in-world, making it easy to maintain and alter content without any SL or scripting expertise needed.
- *Platform neutrality:* all the structure and non-3D content of the exercise is stored on the web making it independent of platform meaning it can be easily ported to other platforms and technologies (e.g. mobiles) if required.
- *Accessibility:* PIVOTE provides a platform where if learners do not have access to a SL capable PC they can still participant in the scenarios via a simple web interface.
- *Reporting*: PIVOTE records all interactions that take place in world between objects and learner for analysis online at a later date.

However PIVOTE has two major deficiencies which OPAL has been designed to overcome. Firstly, the PIVOTE editor was based around the structure of the MVP standard, rather than around user/editor tasks. This meant the user had to understand the concept of MVP, a relatively complex tasks with some of use XML tags. With OPAL we have moved to a more "e-Drama" like model, where the editor talks in terms of "props" and "actors", to each of which, the user can add behaviours and actions.

Secondly, whilst PIVOTE abstracted the non-3D elements of the learning (the text/media content and logic) into a neutral form (the XML MVP standard), it still relied on virtual world skills to layout the 3D space, and to replicate it when multiple sessions were required. With OPAL we are managing the whole 3D environment as well as the learning. This is being achieved through a "kitchen designer" approach. The editor, which is still web based, presents the author with a 2D drag and drop design environment. The author can choose the "props" and "actors" from an environment specific inventory (e.g. classroom, beach, moon-base), and drag and drop them onto the 2D layout area. Once in position the author can click on the object to set its behaviour. The inventory objects (and their 2D icons used in the drag and drop) are mapped to pre-built 3D objects within an interface unit in the virtual world, so when the author presses Build the whole scene will rez in the virtual world [9].

3D Virtual Scenarios in a School Context

OPAL and the virtual scenarios it generates are well matched to socio-constructivist principles of teaching and learning, which underpin the pedagogical principles followed by Academy360. In particular pedagogical approaches such as problem based learning (PBL) and inquiry learning lend themselves to the use of OPAL for generating and populating scenarios which are student centred and driven. In this contexts Academy 360 has identified the International Middle Years Curriculum (IMYC) as the ideal starting point to implement the tool. All IMYC units provide a central theme and a 'Big Idea'. Themes include Balance, Creativity, Discovery and Risk. All of the units have the following elements in common: an entry point (a one-day event, happening or activity which sets an exciting context for the students); knowledge harvest (students are asked about their own knowledge); learning activities; reflective journaling; and an exit point (a one-week long deep-learning exercise for students to think and reflect individually and collaboratively while producing one of six different media presentations).

Currently under development are two scenarios, one for use by 11-12 year olds, and the other for teachers for their own professional development. The scenario aimed at students is designed to complement the theme of Discovery, the Big Idea of which is 'Finding out how new things is a human driver and affects things for better and worse.' In future, it is envisaged that users – both teachers and students – will develop 'user generated contexts'[10] with the tools sets that are being developed, and that this will weave together opportunities for deep learning, intrinsic motivation, situated problem solving.

Conclusions

The development of a tool like OPAL presents opportunities and challenges which may enable mainstream schools and teachers to enjoy the benefits and affordances of 3D environments demonstrated in other contexts, such as higher education and vocational learning. It will enable teachers with limited technical ability and confidence to create their own unique scenarios for use in 3D environments and will challenge their pedagogical thinking which may be rooted in a contemporary 2D contexts. More significantly, for the school at the heart of this case study, it offers the opportunity to enable student driven scenario creation in 3D worlds, a process which has previously remained unattainable. In the pilot phase of development teachers and students will work as co-constructors to explore and design their own scenarios using the OPAL interface. The research team will investigate the impact of the tool in terms of usability but will primarily be concerned to identify how users (both teachers and students) construct their own contexts for learning (user-generated contexts) and what benefits are generated by working in these environments compared to traditional learning spaces. Early indications suggest teachers will need to reconsider their existing pedagogical thinking and patterns in order to extract the maximum benefit from working in these new contexts. However students may be empowered by these contexts and their flexible designs to engage in learning at a deeper level than is currently the case.

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Using 3D Virtual Worlds to Support Geographically Distributed Software Development Team

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Abstract. Today's software development projects are generally performed by development teams that are geographically distributed. This trend also introduces a number of complications when it comes to communication between stakeholders, coordination of work, and control of the project. This paper reports on a prototype of an environment in a 3D virtual world which supports distributed software teams working on tasks. In this environment, virtual team members share a common space, communicate through multiple communication channels and have better team awareness, which ultimately helps them to complete software projects. This paper elaborates on the complexities within distributed teams as well as the different technologies that were employed to connect geographically dispersed co-workers. The requirements of the software development processes are implemented in the virtual world prototype to enable distributed teams to perform their work efficiently. The prototype is based on Sun's Project Wonderland. A study involving developers and users was conducted which shows that the environment in virtual worlds can support the software development and project management disciplines in distributed settings. Richer and numerous communication possibilities, different applications and the ability to work with colleagues in a shared space help distributed software teams to overcome the barriers of physical separation.

Keywords. Global Software Development, Distributed Team, 3D Virtual World Environment, Virtual Teams

Introduction

The globalization phenomenon has had a huge impact on all businesses and industries. The dependence on software in most organizations and the globalization aspects associated with it has led to the transformation of the way in which software is developed today. Today's software is increasingly being developed by teams whose members are distributed geographically. This distributed development carries many potential opportunities such as cost reduction, shorter turnaround time to market, bringing together a variety of expertise, and promised economic benefits. The shortage of local skilled workforce also forces many organizations into this business model [18]. The distance between team members imposes many challenges and complexities in the software development process and thus toughens the achievement of these opportunities. The most challenging issues include inadequate communication, disjointed processes and uncoordinated project management [15]. In order to counter the complexities that emerge from geographical distance issues and to improve the work conditions for members of distributed teams, a number of communication technologies like e-mail, audio conferences, videoconferences and others, have been developed in the past years. However, due to very limited capabilities of these technologies when it comes to conveying non-verbal and emotional cues, they had very little success [25]. The emergence of virtual world technology in recent years has provided some interest in the adoption of virtual world over traditional communication technologies. Moreover, many companies have recognized this potential and have started to exploit them for various reasons that range from marketing to providing their workers with a common virtual workspace. The use of virtual world technology raises a question of whether the virtual world technology could be used effectively in geographical dispersed teams for software development activities.

To examine this, there is a need to create a collaborative environment to experiment the use of the virtual world technology. In view of this, a 3D virtual collaborative environment was created for the purpose of this study. The aim of this paper is to report on the prototype that supports development team members who are dispersedly located. The goals of the environment are to provide better communication channels, increase team awareness, enhance team meetings, support project management, and provide functionality needed to complete software development activities. Parts of the paper, in particular the development and experimentation section, are based on a research project which is described more in detailed in [31].

1. Globally Software Development

1.1. Background and Motivation

Globalization has increased the connectivity and integration in the political, cultural, social, economic, and technological systems between nations, corporations, and individuals. It has also led to emergence of worldwide production or consumer markets, emergence of worldwide financial markets, spread of political sphere of interests, increase in information flows, and new ways of developing information systems [11], [9]. A wide range of industries has also recognized the vast potential that globalization produced. Similarly, the software industry has also begun using economic advantages of globalization as well as the advances in Information Communications Technology (ICT) to support software development. As a result we now have a global dispersion of activities known as *Globally Distributed Software Development* or *Global Software Development (GSD)*. GSD is software development that uses teams of developers from multiple geographical locations. In addition, today's software development is increasingly taking place in a multi-site, multi-cultural, and globally distributed environment. Sundeep as cited in Mohagheghi [23] defines GSD as 'software work undertaken at geographically separated locations across national boundaries in a coordinated fashion involving synchronous and asynchronous interaction'.

In contrast to traditional software development where the teams are co-located, distributed project development requires a higher level of organization and coordination [17, 21], in particular concerning (1) communication for information exchange, (2) participation of groups in activities and (3) control of groups and artifacts such as quality, visibility and management of the development activities. Although global software development introduces new complexities with regards to communication, participation, coordination, and control of projects, there are many technological, organizational, and economic factors that motivate companies toward this trend. The most cited motivators for GSD include Cho [6], Herbsleb & Moitra [16], and Carmel [2]; and some of the motivating factors include benefits in development costs, pool of skilled workforce, economic benefits facilitated by time zone and customizing to local market needs.

1.2. Social Aspects of Software Development

Software development is a technical and a social discipline, and the work is always performed in teams. Whether an organization is implementing traditional, distributed or virtual GSD projects, the crucial building block of the project are the developer teams. Cohen and Bailey [8] define a team as ‘a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems (for example, business unit or the corporation), and who manage their relationship across organizational boundaries’.

In the traditional, co-located software development, the work is performed by teams within a face-to-face context. Similarly, virtual software teams are the work units of distributed or virtual GSD. Lipnack and Stamps [18] argue that virtual teams have the same goals and responsibilities as traditional teams. However, the virtual teams operate across time, geographical locations and organizational boundaries that are linked by communication technologies. O’Brien as cited in Casey & Richardson [3] formally describes a virtual team as ‘a team whose members use the internet, intranets, extranets and other networks to communicate, coordinate and collaborate with each other on tasks and projects even though they may work in different geographical locations and for different organizations’. Wong and Burton [30] characterizes and describes virtual team as follows:

- ***Virtual Team Context*** is characterized by low team history, often with no history of working together, and the team members are usually distributed. The work activities are usually of novel or non-routine tasks completed within tight deadlines.
- ***Virtual Team Composition*** is characterized by the heterogeneity in their cultural and organizational backgrounds. Lipnack and Stamps [18] found that due to the unique cultural and organizational backgrounds of team members, the mix of skills, knowledge and talents, maximizes the potential of the team to take advantage of market opportunities.
- ***Virtual Team Structure*** tends to be connected by lateral communication ties because of the physical distance between the members and the nature of the work they perform. The team members have an efficient flow of information, however, the ties between members tend to be weak because of the lack of face-to face interactions which are often required involving cross cultural and organizational boundaries.

1.3. Distance as Key Complexity Factor

The physical distance that is imposed on team members working in a distributed environment is found to have the greatest influence on the collaboration issues in software teams. The distance also has negative influence on other factors such as coordination, visibility, communication, and cooperation [4]. It has been known that physical proximity of co-workers has a great influence on collaboration. Kraut et al. in Brander and Mark [1] found that collaboration is more effective if people in the building are located closer to each other. Allen as cited in Herbsleb et al [15] claims that the frequency of communication among team members decreased with distance. Furthermore, he stated that in cases where the developers' offices were about 30 meters or more apart, the frequency of communication dropped to almost the same low level as in cases where the offices are separated further apart.

1.4. Issues within Virtual Software Teams

The distance between the members in a virtual team, the lack of face-to-face contact, the cultural and organizational diversity complicate the work of virtual teams.

Powell, Piccoli, and Ives [25] summarize the results of current research on virtual teams and present the issues that the virtual teams face around the life cycle model. *The virtual life cycle model* includes four general categories of variables: inputs, socio-emotional processes, task processes, and outputs [25].

Inputs represent the design and composition characteristics of the virtual team and the benefits of resources, skills, and abilities with which the team begins its work. Relationship building, cohesion, and trust are the most important *socio-emotional processes* within virtual teams. Their existence has positive effects on team performance. However, they are very hard to realize when the team members are separated by physical distance. In order for a team to be cohesive and trust to take place, the team has to build relationship with each other. Team interaction that fosters inclusivity or a sense of belonging is important for the success of a team. Research has found that there is a positive link between socio-emotional processes and outcomes of the virtual team project. It has also shown that virtual teams are confronted with unique challenges when it comes to meeting socio-emotional needs of virtual team members [19, 20, 27]. *Task processes* are defined as 'the processes that occur as team members work together to accomplish a task or goal' [25]. In the task processes category there are major issues regarding communication, coordination, and task technology-structure fit. The *outputs* of virtual teams include the performance of virtual teams as well as the members' satisfaction with the virtual team experience.

Wainfan and Davis [29] listed three principal modes of virtual collaboration: audio-conferencing, videoconferencing, and computer-mediated communication. The problem with such mediated communication is that it limits nonverbal, para-verbal, and status cues. It also reduces the 'richness' of the information communicated. Krauss and Bricker as cited in Wainfan & Davis [29] also found that the discussion in mediated communication tends to be less social and more task-oriented than in face-to-face communication. Ultimately, all above mentioned communication media have limitations. Immersive collaborative environments such as 3D virtual world can mitigate or even overcome the above issues on collaborative environment [13].

2. VIRTUAL SOFTWARE TEAMS AND 3D VIRTUAL WORLDS

Various companies have recognized the potential of virtual worlds. These companies expect that the visual, aural, and spatial dimensions of virtual worlds will enrich electronic interaction between virtual collaborators. These included chat, avatar customization and others. Although 3D virtual worlds have their roots in games, today's virtual worlds have taken a different course and focus on subjects like distance teaching and learning, virtual collaboration, and social networking [7, 11, 12, 13, 28].

According to Owens et al [24], a virtual world is 'an instantiation of a metaverse - a fully immersive 3D virtual space in which people interact with one another through avatars and software agents.' Castronova [5] also lists the most important characteristics of a virtual world with the defining features of interactivity, physicality and persistence. In this presence, teams are able to interact simultaneously and work together virtually in a physical sense. Once the environment is established, all parties are able to interact and meet at a virtual location. The virtual world representation should resemble the real world [26]. The environment also supports multiple users and incorporates social networking capabilities [9].

The advantages of virtual worlds for communication and collaboration when compared with other communication options have been recognized by a large number of organizations [14, 22]. Moreover, the application of virtual worlds in context of collaborative learning activities and knowledge transfer was also reported in Gütl, Chang, Kopeinik, & Williams [12].

According to Owens et al. [24], 3D life-like conversation and an immersive environment for interaction, purposeful nonverbal communication (even the ability to touch), the ability to control avatar appearance, and avatar behavior, virtual worlds can help to reduce the effects imposed by geographic distance and cultural differences. Virtual teams can also take advantage of the concurrent use of multiple communication channels and where team members can socialize and engage in non-formal communication. Virtual world environment also allows the opportunities for immediate feedback during team communication, development of trust through multiple channels of communication, elimination of geographic boundaries, and the ability to see one another's artifacts as team members work on them [24].

3. RESEARCH METHODS AND DISCUSSION

The context thus far has elaborated on the complexities with developer teams to connect and work with co-workers in geographically dispersed locations. Increasingly, organizations are implementing virtual team strategies and relying on ICT to link geographically dispersed team members. Just as team members in co-located environments collaborate to accomplish their tasks and objectives, virtual team members must also collaborate virtually to deliver the end product. The software industry has identified the need for virtual collaboration and there exist technologies and tools to address this challenge.

The use of virtual world technology raises a question on whether the technology supports teams operating in geographical dispersed locations. To explore this further, the first requirement was to build a prototype of a virtual world collaboration environment to support virtual team collaboration. The virtual environment must allow the developer teams to meet, interact, communicate and collaborate on projects; and for developers and users to work closely together. The prototype environment is created using a room metaphor technique and will include rich communication channels, tools and applications. Accordingly, the virtual collaborative environment serves two purposes. Firstly, an environment which was created for a team of developers to work in a virtual setting to perform software development activities. Secondly, for developers and users to work collaboratively in a virtual environment.

In view of this, the overall goal of the study is to address the following research question, “Does the virtual collaboration environment prototype support software development activities that virtual teams participate in?”

The functionality of the virtual collaboration environment prototype will be presented through a usage scenario. In this study, the scenario involves four developer team members who are distributed geographically; the project manager also a developer is located in Graz, Austria, two developers working in Vienna Austria, and another software developer who works in Barcelona, Spain. To further test the virtual collaboration environment, five users were also invited to work with the developers to ascertain the usefulness of the virtual environment.

3.1. Prototype of the Virtual Collaborative Environment - High Level Requirements and Design Aspects

The virtual GSD environment was developed in Sun’s Project Wonderland which is implemented entirely in Java. (Project Wonderland is now an independent community-supported open-source project named Open Wonderland - http://openwonderland.org/). It uses a number of open source application that provide the virtual environment with the required functionality. The environment is created from 3D graphical models and the rooms in the environment were created in Google SketchUp (http://sketchup.google.com/), while other graphical elements were either created in graphical editors or downloaded from Google 3D Warehouse (http://sketchup.google.com/3dwarehouse/). The virtual GSD environment must allow for the distributed development teams to meet, interact, communicate and collaborate effectively on a particular project. As shown in Figure 1, the prototype environment created using a room metaphor includes rich communication channels, tools and applications.

The design of the virtual environment will incorporate distributed team issues of communication, team awareness, project management, and software process development activities. As such, the virtual environment includes areas that are divided into rooms. The areas are (1) Planning, (2) Software Development, and (3) Social. The Planning area comprise of the Organization and Meeting Rooms. The Software Development area includes the Analysis, Design, Implementation and Testing Rooms that will contribute towards the functional activities within the software development project. The final area which is also an important room is the Social Room where team socializes and may possibly work on activities within the project in an informal setting.

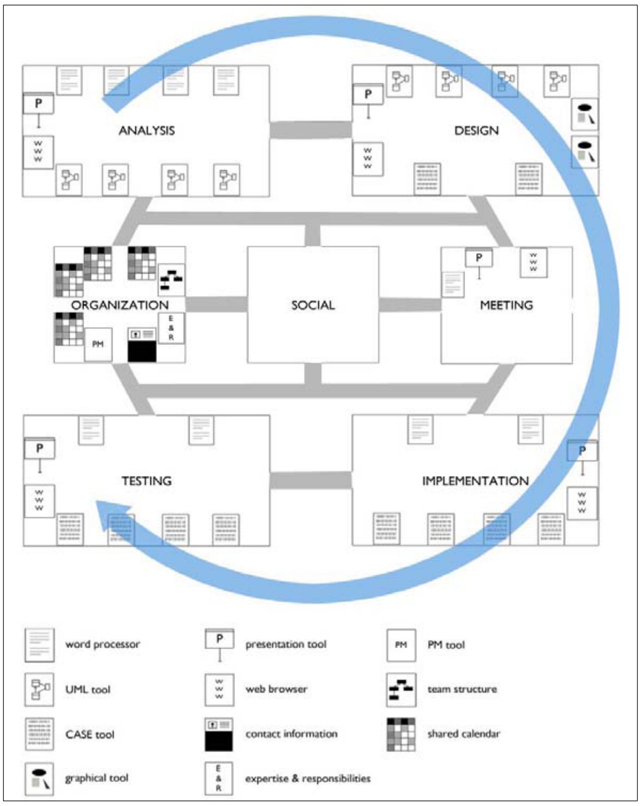

Figure 1. Layout of the virtual collaborative prototype environment

3.2. Developers' Tools within the Virtual Collaboration Environment

In terms of communication, the developers will use the multiple communication channels and engage in real-time immersive audio conversations, stereo audio and also text chat via the text chat functionality. The conversation can be private and/or public and these communication channels help team members to communicate, discuss urgent issues, and perform project related activities. In the event that a team member is not present in the virtual space, other team members can use asynchronous communication or leave a *Sticky Note* object for the team member (see Figure 2).

When it comes to team awareness, the virtual team members can benefit from multiple capabilities. By observing the avatars of the other members, the developers can see what they are currently working on and where they are located. This is supported through *telepresence* and the use of transparent room walls. In addition, the organization room fosters team awareness. If, for example, a team member was not present in the environment, other team members can check the shared calendar to find out where he or she is as well as when he or she will be back in the virtual world (see Figure 3). As seen in the figure, the Organization Room also displays images containing the team structure, expertise and responsibilities of the software developers.

Figure 2: Environment supports variety of verbal and non-verbal communication channels.

Figure 3: A shared calendar, team structure, and expertise and responsibilities in the Organization Room

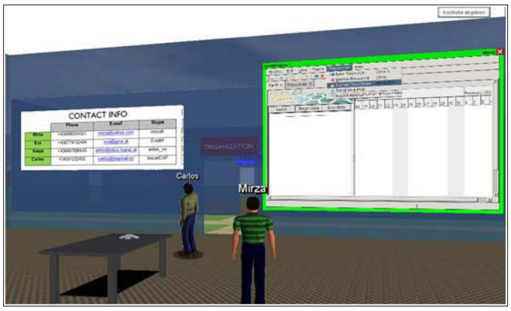

Figure 4: Gantt chart and contact information in the Organization Room

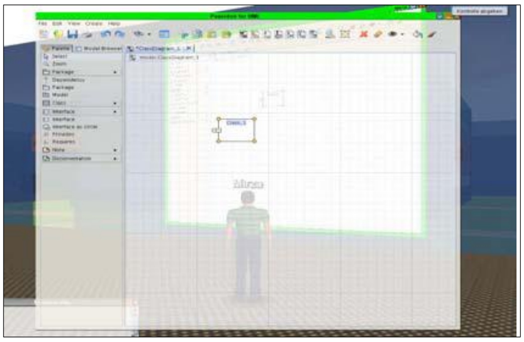

Figure 5: Shared application such as Poseidon's UML in the environment

In terms of project management, the Organization Room (Figure 4) provides the virtual software team with a project management tool. The project manager can use this application to run and control the execution of the project. Team meetings, presentations, and client meetings (provided that the clients have avatars representation) can be held in the Meeting Room.

With respect to software development activities, one of the important functionalities in this prototype is the availability of shared applications (see Figure 5). The software development activities are supported by the shared applications found in the Analysis, Design, Implementation, and Testing rooms. The software developers in the virtual environment can use the applications to perform the tasks required in the project. By using the applications, every created document or file is stored on the server and can be accessed from Wonderland when needed. Another advantage for the collaboration is that all team members can use the shared applications and conduct work simultaneously.

It is also very important that the developers are able to navigate easily through the environment. Apart from signs available at each entrance to a specific room, an additional functionality in Wonderland that helps teams when it comes to navigation is the use of *Placemarks.* This enables users to immediately teleport themselves to other locations, such as participating in a discussion in the meeting room.

3.3. Users' Perspective of the Virtual Collaboration Environment s

In order to test the prototype with users, five participants were sourced to ensure the impression, including the functionality and usability of the environment. Of the 5 participants, one was female and four were male. The functionality of the environment was presented to the user participants and they were asked to use and explore the environment. Two surveys were conducted, pre- and post-surveys. The pre-survey assesses the participants' background using computer tools for communication, organization and coordination of work with their peers, usage of mobile devices, using 3D multi-user environments, and their experience and knowledge about software development and project management in a distributed setting.

The pre-survey analysis showed that participants frequently used different tools and applications to communicate, organize and coordinate work with their colleagues in virtual settings. Four out of five participants use Skype and MSN for communication with their colleagues. One participant used Second Life occasionally and the other participants rarely or never use 3D virtual environments. All participants are active users of mobile devices. All had some level of experience with software development but little or no experience with project management.

In terms of the post survey, the participants were asked for their impressions about the virtual collaboration environment in general and in context of application in distributed software development and distributed project management. In addition, they were also asked about things they did and did not like, as well as suggestions for the improvement of the prototype in all contexts.

When asked about their impression of the applicability of the virtual environment for distributed software development, the participants agreed that the environment provided a very good impression in that three participants liked the presence of different facilities for communications, whereas one liked the possibility of working with other people synchronously, and one liked the separate rooms for the different software development activities.

On the negative front, all participants commented on the slow performance of the system. One of the participants did not like the graphics and one did not like the inability to enlarge windows of shared applications. However, the participants favored the ability to 'keep in touch' and assist each other. One participant commented the usefulness of being able to collaborate and work on the same document. This provided them with the view of being in control and kept up-to-date with all the development activities.

The environment was also assessed in context of the application for distributed project management. Although most participants liked the same things in context of software development and project management, two liked the ability to track the progress of the project in real time and another liked the presence of the project management tool. All the participants agreed with the potential use of virtual collaboration environment to support software development activities.

In view of the above developers and users' views, it can be concluded that the prototype supports the virtual world environment for virtual team collaboration. Moreover, the adoption and usage of the virtual collaboration environment will increase if the ease of use and navigation are stable along with a faster performance of the system.

On a more general viewpoint, just as with any technology, the possibilities of virtual worlds also come with some challenges. Owens et al. [24] enumerate the following challenges of virtual world technology and these challenges were also echoed by the developer and user groups:

- **Client software and hardware** – each team member has to download client software that requires sufficient memory and graphics. In addition, the virtual world audio capabilities are not robust.
- **Learning curve** – to exploit its full capabilities it can take a considerable effort to learn to operate within the environment.
- **Balancing worlds** – the project managers need to realize that a virtual world is not a substitution for the real world. Some cases could still require traditional face-to-face meetings.
- **Acceptance** – the confidence in this technology must be present that the project manager and employees are going to use the technology.
- **Distractions** – people's avatars could wander off and drift away.
- **Norms of behavior** – some users could differ from usual norms of behavior (i.e. not convey their thoughts when using virtual world technology).
- **Uncertainty of behavior** – there is no control over the behavior of other people's avatars.
- **Representation** – working through a virtual persona might request adjustments from some users.
- **Security** – virtual worlds are often public places with limited security features.

4. CONCLUSION AND FURTHER WORK

The requirements for a prototype of the virtual collaboration environment for software development include the need for a richer communication between team members, better team awareness, support for meetings, project management, and the ability to perform software process related activities. However, in order to effectively use the environment for such purposes, it has to have great performance, be highly reliable, and developers and users have to be able to navigate the environment with ease. In the virtual environment, the virtual team members can communicate via multiple communication channels. In order to reinforce team awareness, the environment displays important information such as a shared calendar of every software developer's schedule and the team's expertise and responsibilities, and the contact information of every team member. In addition, the software developers in the virtual environment can also observe the avatars of their colleagues and know if they are present and what they are currently doing. The room metaphor is also helpful in that it helps to organize and structure the work. Team members can also share their work and data through the use of shared applications. The Meeting Room in the virtual environment also provides a place where teams can meet, hold presentations and possibly manage meeting with clients.

The user study shows confidence about the application of the prototype for distributed software development and project management. The users were satisfied with the ability to work together in the same place, the presence of different communication ways, and the ability to track the project progress as well as the notion of rooms in the environment. The study also shows that the performance of the virtual environment needs to be better in order to support its usability and acceptance. One of the limitations of this study was the small sample size of both the developer and user groups, although it was a decision that was made deliberately to test the environment aspects of virtual world. One of the next steps is to improve the virtual environment based on the findings of the study; and test the environment in a real setting. Another focus of interest is to specifically create a virtual environment to support agile programming.

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Assessment of an educational online virtual game enviroment: the case of SimSafety

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Abstract. Although the purpose of online virtual games is users' satisfaction, they may be used as an educational tool as well. This paper presents a quality evaluation procedure along with its results, of an online virtual game environment with educational purposes, named SimSafety. The SimSafety virtual environment supports role-playing game scenarios in real-time and dynamic groups of online users. During the interaction with SimSafety environment, players (which are children and parents) are exposed, through a controlled and safe environment, to virtual internet threats in order to get familiar with them and learn how to overcome them. The evaluation procedure conducted in the Software Quality Laboratory of the Hellenic Open University. A brief presentation of games' usability evaluation framework is presented while the relation between games and learning is discussed.

Keywords. Online virtual learning environment, game usability, quality evaluation

Introduction

Online virtual games, apart from the entertainment they offer, may also be used as educational tools. In this case of using games as a means for education, the issue of usability in a game environment is very significant in order to enhance users' challenges. In this study, game usability is defined as the degree to which a player is able to learn, control, understand, be intrigued and enjoy the game. Many of the usability issues which arise in games are similar to those which arise in other software applications areas. Nevertheless, the need to focus on games usability and how usability principles are incorporated into games is emerged.

This paper presents the evaluation of an online virtual game environment used for educational purposes. The aforementioned virtual environment is "SimSafety-Flight Simulator" (http://www.simsafety.eu) which enables users to follow role-playing game scenarios in real-time, supporting dynamic groups of online users and exposing players to virtual safety traps. In SimSafety's environment, players get familiar with the internet threats and eventually learn how to overcome them, or even better not to get involved in the first place. Furthermore, SimSafety environment is not just a conventional game, since it promotes socialization, educational actions and protection of internet exposure of a sensitive target group such as children. The target group of this particular game is children in the age of 9-13 and its major purpose is to expose them, to internet risks with a safe way. The evaluation of SimSafety took place in the Software Quality Laboratory of the Hellenic Open University (HOU). Software Quality Laboratory operates within the frames of Software Quality Research Group (SQRG) (http://quality.eap.gr) which focuses on Software Quality Assessment and Software Evaluation, placing special emphasis on educational software quality. Software Quality Laboratory is a controlled laboratory environment, suitably equipped for the performance of usability tests of various software systems.

The rest of this paper is organized as follows; in section 1, usability evaluation issues for virtual games environments and their relation with learning are briefly presented. Issues relative to learning theories for games and learning are presented as well. Section 2 is a brief description of the SimSafety environment, its aims and objectives. Section 3 enlightens the evaluation procedure and goals as well as the profile of the players participated to the SimSafety's evaluation. Section 4 presents the evaluation results and discusses a number of changes to the SimSafety environment that should be considered in its next version. Finally, section 5 summarizes the conclusion and presents the future goals.

1. Usability and Learning in Relation to Games

Initially games were developed for entertainment, nevertheless, most of them have a scenario and a problem to solve in order to achieve their goals and come to an end. Games' usability is an important factor in order the game to be used with pleasure and satisfaction from the candidate player.

1.1. Usability of Games

Usability issues in games' compared with other software applications' interfaces, have to deal with different parameters and examine a wide range of subjects. An example of a different usability consideration for games is user errors. In many other applications, user errors are not desirable, but in games are more than expected. Therefore, due to the games' designs, which have the intention to challenge users to find the way to achieve their goals, errors are expected [1].

A more generic (i.e. not always applicable in games) definition of usability is "the aspects of effectiveness, efficiency and satisfaction". Effectiveness relates to the accuracy and the achievement of the user's predefined goals, efficiency describes the resources used to achieve the goals and satisfaction is referred to user's emotions [2].

So far, there is not any definite method to measure usability of a game. Nevertheless, games' usability is depended on the easy way in which a player is able to start, understand the available functions and the goals of the game and finally play the game. Efficiency is affiliated with the resources which are used by the player in order to achieve the goals of the game. While, effectiveness is related with accuracy and the user's achievement goals in order to reach the end of the game, or achieve a goal. Also, satisfaction is associated with the players' mood.

Considering that the initial goal of a game is user's enjoyable satisfaction, which consists of aspects of fun, immersive environment and experience of a user, is a major parameter in order to measure usability of a game. Games like other applications have an interface which is important to provide an effective and efficient interaction with the user. Another essential aspect of usability of a game is playability, which has a major role in games' design, but in different point of view compared with effectiveness and efficiency of its interface [1,3,4].

All aforementioned usability aspects for a game can be classified in three categories: game interface, game mechanics and game play. Game interface is referred to the devices, such as keyboard, mouse, controller, which a player use to interact with the system. Game mechanics include the ways the player is authorized to act through the game environment, such as walk, jump, fly etc. Game play is the total actions of the player in order to achieve the goals of the game [5]. The usability of aforementioned categorization is relevant with the type of the game (eg. adventure games, role-playing etc.) and the platform machine (eg. pc, console etc.) which are used [3].

Consequently, a more specific definition for usability in games is the point of view in which the player is able to learn, control and understand the game. This definition relies on previous studies, which were focused on usability issues and on playability heuristic rules.

1.2. Games and Learning

Games, in their infancy, received severe criticism for their negative influence to users, such as addiction, unsociable affect or violence behavior. However, recent researches have shown that games have mainly positive points of view. Some of the positive characteristics of games are their educational aspect [6], enhance of collaboration and socialization [7], enforce of logical thinking and decision making [8]. Moreover, games are used to academic community in many levels and they proved to be very useful specifically for the enhancement of the students' motivation. Additionally, games demonstrate practical skills, stimulate perception and problem-solving skills, strategy planning, tools organization and obtaining intelligent answers.

Many games have a scenario and a problem to solve in order to achieve their goals and come to an end. In this way, logical and critical thinking are enforced during the game. The game "Lord of the rings", enforces book reading, while "Civilization IV" enhance observation, logical thinking, geography, problem-solving and decision making. Furthermore, "Total war: Rome" is an example of strategic planning game and "Sims" and "Second life" are games of social simulation [9].

Students' motivation and interest for learning is enhanced when "fun" embedded to the educational process [3]. Many researches support the idea, of teachers using video games in the educational procedure [10]. Communication and interaction among teachers and students can increase in and out of the classroom if they use video games during teaching. Video games are considered to be a strong educational tool which provides teaching information and learning outcomes. Moreover, provide to teachers a new way to share their knowledge and extend the traditional teaching methods. By using a video game through the process of an educational activity, teachers create all the appropriate conditions for the students' future challenges and students can improve their skills [11].

Many educational theories and learning efficiency are affiliate to games' environments. The theory of *experiential learning* (i.e. if you do it you learn it) is a basic game's parameter which support the navigation of the users in the game's environment according to a game scenario but also allow them to take their own decisions which affect the outcome of the game. The player may repeat the same action many times in order to achieve the success of an activity. Theory of *inquiry-based* *learning* (i.e. what will happen if I do that?) is related to games in which players allow to navigate without any restriction. In these environments the users try new ways in order to overcome obstacles that emerge. Moreover, the theory of *self-efficacy* (i.e. if you believe, you will manage to succeed; you will try much harder) is relevant to games in which the player's motivation enhance by the items collection when specific goals were achieved. Another theory is *learning through a specific target* (i.e. you learn better if you work on a well set target) which concerns specified game's objective. Furthermore, theory of *cooperation based learning*, studies in classrooms have testify that working in a group instead of individual learning process improves significantly the learning process outcomes [12].

2. Aims and Objectives of SimSafety

SimSafety, the acronym of Flight Simulator for Internet Safety, is an online virtual reality game environment for children. SimSafety provides to players, in this case children, a safety environment while expose them to internet risks. Furthermore, supports role-playing game scenarios in real-time, dynamic groups of online users and expose players to safety traps in order to learn how to overcome them. Additionally, SimSafety has a 3D environment that provides a wide range of activities in order to achieved predefined goals. Through playing in SimSafety environment, children enhance their socialization skills, they learn about internet safety and other things [13].

The game environment exposes its users to potential risks but "safely". Furthermore, is innovative if is compared to other games due to the fact that enhance interaction between the players and promote learning through experience of playing. The environment includes game scenarios, addressing dynamic online user groups and exposing them to coherent actions and events. Also, in order to deal with complexity and difficulty issues, SimSafety includes challenging game rules (e.g. scoring, game awards) that will ensure re-playability and scalability of game levels. Moreover, eliminates the "digital gap" between parents and children or teachers and pupils, and enhance the collaboration between them. The game environment is also supports the communication and collaboration between targeted groups from different countries [14].

3. Evaluation Procedure

The aim of this study was to assess the quality of the SimSafety Online Virtual Game environment and to provide feedback, using the results of the assessment, regarding the improvement of the game's environment. The mentioned assessment was based on the ISO9126 standard [15], which describes "Quality" using six factors: *functionality*, *reliability*, *usability*, *efficiency*, *maintainability* and *portability*, which are associated to a number of criteria in a hierarchical manner, and finally to a set of metrics.

Due to the use of the OpenSimulator platform, maintainability and portability factors were assured. Therefore, the emphasis was placed on the remaining four quality factors (especially usability), which affect directly the users. The OpenSimulator is a 3D Application Server, capable of hosting massive multiplayer on-line 3D environments. This platform has many similarities to the "Second Life" environment, since it is a project inspired by Second Life. Despite being at an early stage of development, the platform proves to be quite stable and robust, even when serving many concurrent users [16], therefore maintainability and portability issues were resolved due to the participation of the open-source community.

3.1. Evaluation Methodology

The methodology used for the evaluation of SimSafety environment, included assessment methods such as *Actions Logging*, *Experts Observation* and *Interview*. It should be mentioned at this point that, there were some limitations regarding the choice of the methods employed, since the users participated in the assessment were children of ages among 9 - 13 years. Therefore evaluation methods more suitable to adults, such as the Thinking Aloud Protocol, or Co-discovery could not be used.

Actions Logging (or User Logging) is an evaluation method that includes recording of all user's activities, during their interaction with the interface under assessment, by the use of specialized equipment and software. In this case, the equipment used was 2 cameras, 2 microphones, hardware VNC and specialized logging software. Experts Observation added the evaluators' comments to the data gathered by various sources. In this case the experts' recorded comments were combined with the video from the camera recordings. The collected data were digitally archived, synchronized and analyzed using Observer XT software. Finally, the data collected from the Actions Logging and the observation was compared to the findings from the interviews.

Figure 1. View from the recordings inside the observation room.

Figure 1 presents the view of the evaluators (real-time recordings of the evaluation procedure), inside the observation room. The screen on the left shows the video from the roof camera which is combined with the audio recordings of the evaluator's comments. The screen on the right shows the video captured from the PC in which the child is playing the game, combined with the audio captured inside the test room.

During the evaluation procedure, a number of peculiarities came up. A significant one was the transfer of users in and out of laboratory's test room. Usually, changing the users into the test room, during an evaluation procedure (according to the needs of the evaluation), is quite easy when adults are involved. In the case of SimSafety evaluation however, some of the children did not want to stop the game. On the contrary, adults sometimes feel peculiar inside the test room, due to the fact that they were monitored and all their actions are recorded. In this case children forgot all about the observation and the evaluation procedure, after a while, and focused almost entirely on the game.

The overall evaluation process, including the breaks, the initial orientation, the discussion and switching in and out of the test room lasted approximately 5 hours. Out of this time just over 3½ hours was the actual evaluation recordings. Finally, the overall time to analyze the archived data was approximately 18 hours.

3.2. Setting of the Evaluation

The evaluation of SimSafety environment took place in a suitable controlled setting where the performance of users in preplanned tasks was able to be measured. This controlled setting was the Software Quality Laboratory of HOU. An overview of the laboratory is presented in figure 2.

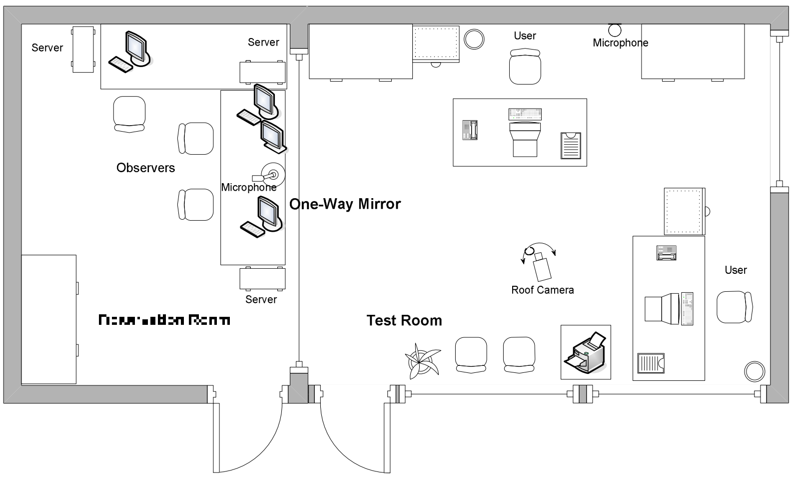

Figure 2. The Software Quality Laboratory of HOU.

The Software Quality Laboratory comprises of two rooms, the *testing room* (on the right in figure 2) and the *observation and control room* (on the left in figure 2). The observation room is separated by the testing room by a *one-way mirror* so that the members of the quality evaluation team can watch the children play SimSafety, but not vice-versa. The maximum number of persons inside the testing room is two children (accompanied by their parents) and –in some cases– a member of the assessment team, depending on the case study. All other members of the assessment team were sited inside the observation room viewing the evaluation procedure.

The laboratory equipment installed and used during the assessment consisted of one roof-mounted video camera that records the player’s behavior, such as hand movements, facial expression and general body language throughout the experiment, a microphone that was placed close to the players, in order to record their utterances and another microphone that was installed in the observation room to record evaluators' comments.

Video from the camera as well as the real time image of the participant's monitor are both directed to video monitors into the observation room where they are recorded for further evaluation. Since the members of the assessment team are not in the same room with the players this eliminates almost entirely any possible biasing effects due to inadvertent non-verbal communications or mannerisms. The test room is structured in such a way that gives the player the feel of a normal office room and not a laboratory. Finally the camera (roof-mounted) and the microphone are placed in such a way that are not easily observable, despite the fact that the player is informed of their existence before the beginning of the experiment.

For the experiments conducted with the participation of children and parents, specialized recording software, such as the *Usability Logger* [17] developed by SQRG, was used in order to record all players' actions. This software combine recordings from player's camera and microphone, as well as recordings of all users' actions in the screen (screen captures, mouse movements, keystrokes, and idle time). The use of such software was essential since some games within the SimSafety environment required the participation of 5 children; therefore some children played the game outside of the laboratory, but within HOU premises, in a room nearby and under the supervision of one of the evaluators.

3.3. Participants of the Evaluation

As mentioned earlier, the participants of SimSafety's environment evaluation were children accompanied from their parents. More specifically, six children and five parents (two of the children were brothers) participated in the evaluation experiment. For the setup of SimSafety environment in the PCs available and the technical support required during and after the evaluation, three technicians (members of RACTI, the partner that developed the environment) were present. Furthermore, four members of the SQRG of HOU participated as the evaluators. Out of these four evaluators, two were responsible for the observation and the recording of the procedure as well as the gathering of the data and were sited inside the observation room, one was inside the room where the rest of the children played the game and the other evaluator was available outside the test room to aid in case some advice regarding the evaluation was required.

3.4. Evaluation Scenario

During the evaluation procedure, the scenario used was separated into 7 different tasks. The tasks that that the participants had to complete during the game were:

1. Learn how to navigate in the virtual world.
   Hints:
   - Take a look around, read signs, experiment.
   - Learn how to navigate inside the Online Environment.
   - Follow the signs to go to the SimSafety Park.
   - Try flying around.
2. Visit the world and the house of knowledge. Find out what you should be aware of when you navigate the Internet.

Hints:

- Try to find the House of Knowledge.
- Visit the different Sections of the House of Knowledge to see what is there.
- Wait for a few minutes until you read the signs in the House of Knowledge.
- Information retrieved from the House of Knowledge may be useful in different sections of the Game.

3. Meet new people, make new friends minding the rules you have found out in the house of knowledge.
   Hints:
   - Keep in mind what you learned in the House of Knowledge each time you make new friends in the game.
   - Make Friends in the Game by right clicking on an avatar and asking from it to be your friend.
4. Have you been bullied yet? Follow the reporting procedure.
   Hints:
   - How do you recognize that you have been bullied? Check for Instant Message Notification at the bottom corner on your left.
   - You may get bullying messages, spam messages, advertisement that you do not wish to receive. In that case, you have to react and increase your score.
   - Report bullying in the Bullying Reporting Department. Find the "Bullying Reporting Department", open the door, enter the building and fill in a bully report.
5. Change your clothes. Select something nice to wear. Play an interactive game.
   Hints:
   - It is time for you to have some fun. Visit the "Mall" area (it is next to the "Bullying Reporting Department") and select something nice to wear.
   - There are instructions in there that you can follow in order to change your clothes.
6. There are 4 Quiz points in SimSafety (locate them in the Info Centre, the report centre and the park). Try answering some of the questions (score at least 4 points).
7. Try to return to the welcome region by teleporting (you can search for the welcome region in the map).

4. The Evaluation Results

Analyzing the recorded data from the evaluation of the initial version of SimSafety, a number of issues came up. The majority of these issues were related to the quality factor usability. More specifically, out of the major issues detected, most of them were usability related, whereas the rest were functionality, reliability and efficiency related.

In Table 1, there is a summary of the most significant problems that were detected during the evaluation. In the first column of the Table, the symbols used are *F* for functionality, *E* for efficiency, *R* for reliability and *U* for usability.

Table 1. Significant reported issues

Category	Detection method	Short Description
F	Observation	The goal of the game is not always clear to the children.
F	Observation and interviews	Some videogames perceived as quite 'adult' from the children.
E	Data logging	Delays in the avatar during walking through the SimSafety areas.
R	Observation and data logging	System crashed.
U	Data logging	Children had more fun exploring the environment, rather than playing the games.
U	Observation and interviews	After exploring the area and playing all the games there is nothing else to do.
U	Data logging	The lack of a visible scoring system reduces competition and fun.
U	Interviews	Children asked for more items to use in the SimSafety area.
U	Data logging and interviews	The stating requirements of some videogames are not clear to the children.

Apart from the issues presented in Table 1, some minor problems were also detected that either were not significant and were immediately solved on the following version of SimSafety, or they were depended on the limitations of the 3D environment used. A typical problem of the latter category was the lack of avatars that look like children, since it was not supported in this version.

As far as the usability issues concerned, it was observed that children joining the environment had more fun exploring it, rather than playing the actual game. More specifically, data gathered, showed that they prefer exploring, walking or flying around, teleporting but not playing the game immediately. It was also observed and mentioned in the interviews that after exploring the area and performing the obvious activities of the environment there was nothing else to do. Moreover, the lack of more items that can be used by the players as well as the lack of a visible scoring system reduces competition and fun of the game. Finally, the stating requirements of some videogames are not clear to the children.

The solution to the aforementioned problems was the introduction of items related to internet safety (such as a piece of paper with a login username and password written on it) that children could use freely while exploring the environment, as well the use of bots (virtual people that interact with the children). By introducing the aforementioned items, in the environment of the game, the interactivity was increased adding more fun to the game and increasing the engagement of the player with it. Additionally, the use of a ‘Report Centre’ where a game player can declare a lost and found object or report that he has been bullied aided towards learning while exploring and interacting.

Furthermore, the scoring problem was also solved, adding points into any ‘proper’ action related to Internet Safety and, as discussed previously, more items were added into the environment. Of course not all the items asked by the children (such as bikes, cars, etc.) but only the ones related to the goal of the game, still with some exceptions in order to increase the essential fun element of the game. Finally, regarding the ‘visibility of game status’ and the starting requirements of each game this was resolved by adding instructions and mechanisms to inform the children about the number of players registered in each game and the number of players that are required to start playing.

Regarding the functionality related problems, the goal of the game was not always clear to the children (some videogames perceived as quite ‘adult’ from the children). The solution to this issue was the addition of game play instructions. More specifically, detailed instructions were incorporated in certain areas of the game environment. In addition, an introductory place (the starting place for all first-time visitors) was created, where some basic instruction, regarding the game play, are presented. Despite the addition of detailed instructions, some parts (especially role-playing parts inside the environment) still cannot be played effectively by children. These role-playing parts were kept intentionally, since they found to be suitable for the participation of adults either by impersonating the threats of the internet or making provocative questions and initiating interesting discussions. These games were also found to be very useful when playing within the class, by many students as well as the teacher, or at least one adult.

Finally, the problems related to efficiency and reliability were related totally to the version of the platform used in the evaluation and solved entirely in the following versions.

5. Conclusion and Future Goals

The evaluation presented in this paper was the first, preformed in a suitable setting and adding to identify and solve problems in the alpha version. Further evaluation procedures and mostly the pilot runs in schools proved that all the reported problems were addressed and the results regarding children satisfaction were encouraging and promising in relation to game sustainability. Our future goals are to apply other methods of evaluation in virtual games comparing the effectiveness of the results, find the drawbacks and proposed a way to overcome them.

Acknowledgment

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Team Building in Virtual Environments

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Abstract. While the use of e-mail and video-conferencing systems substantially supports the members of ever more globalized project teams, we have witnessed that the developments regarding Virtual Environments and Communities may have a big impact on project management in the future. The paper illustrates the observations made regarding the team building process in virtual worlds and the lessons learned by the teachers.

Keywords. Team Building, Virtual Environment, Project Management

Introduction

“Coming together is a beginning. Keeping together is progress. Working together is success.”

~ Henry Ford

Education of humankind has come a long way. It would be interesting to know what the ancient Greek educators would have to say about the technical possibilities we have today. *"I have never wished to cater to the crowd; for what I know they do not approve, and what they approve I do not know,"* said the great Epicurus, who lived from 341 BC to 271 BC. One can see the similarities regarding the modern education methods used to train students: teachers have to work hard to meet the demands of the modern-age student, still they have to deliver the mandatory content, which sometimes is not very appealing to the students, thus resulting in frustration and demotivation of both teacher and student and furthermore in less efficient ways of teaching and learning.

Since the uprise of the computer many things have changed in the way people teach and learn. Nowadays one is able to witness the use of software in nearly all fields of education. Virtual Environments, for instance, are among the more innovative and sophisticated types of software used. Due to its newness, many open questions regarding this use still need to be evaluated. This paper aims to explain the team building process in virtual environments and give advice to professionals in the field.

First of all the following questions will be answered:

1. Is there a difference between team building in a virtual environment and in the real world?
2. Why do we need teamwork in virtual environments?

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Team Building in a Virtual Environment can easily be compared to team building in decentralized projects. While the following statements

- Personal contact is decreased to a minimum [1, 189].
- Building up trust with or in the project team is challenging.
- Personal commitment to working with the team is demanding.

hold true for both situations, the statements hereafter are only true for virtual environments:

- Anything that happens in the virtual environment can easily be recorded [2, 125].
- No additional software is needed to communicate, share or present documents.
- Communication in big teams can be handled easily through the centralized virtual environment.
- The "wisdom of crowds" can be used efficiently [3, 145].

Regarding the second question it is important to mention that virtual environments foster isolation, e.g. of a team member. This fact often serves to give virtual environments a bad reputation. Therefore, building a team is crucial in order to leave no one behind.

Powell, *Piccoli* and *Ives* have found four main focus areas of virtual teams [4, 8].

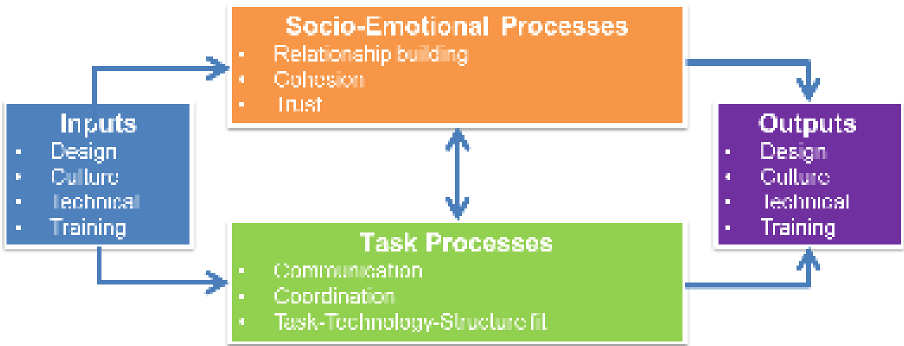

Figure 1. Main Focus Areas of Virtual Teams

The Team Building Process mainly takes place within the Socio-Emotional and Task Processes since all topics described have to be taken into consideration there. It is clearly stated that both processes have a crucial impact on the Outputs and therefore are very important to each project. The Inputs in advance serve as a steering wheel for the team building process itself. If the Inputs are designed badly, team building will be difficult to achieve at all. Cultural aspects have to be considered beforehand, since the Commitment to collaborate within a Virtual Environment is different throughout the world.

To demonstrate the team building process itself, it can be evaluated in real projects. To this end, more than ten projects have been observed in which virtual environments were used.

Setting

Teleplace and openQwaq were used as virtual collaboration tools [see also 5]. Each project team decided to use the virtual meeting room as:

- document repository,
- relay chat,
- newsroom,
- think tank,
- collaboration space, and
- meeting room.

Project team members accessed the virtual room from various locations since all of them were in-service students who also had to do their regular jobs, many with a lot of travel duties. During the initial phase of the projects much communication had to be done using the voice-chat tool of the virtual world. Project team members of one of the earlier projects experienced bad sound quality and huge time lags while talking to each other, which impeded the progress of the project. The reason for these issues was recognized in the fact that the voice chat was operated by the provider using its own servers located in the U.S. A quick solution had to be found to maintain the high team motivation and to proceed in the communication process. The project manager suggested the use of "Team Speak", also used by players of MMORPGS. This suggestion helped to solve this issue with as little time loss as possible. The software was installed on a university server and has been available since then.

Evaluation of Team Building in a Real Project

The project teams most often did not have much experience with virtual environments. Therefore, problems encountered were:

- team members unable to hear/talk to each other,
- very chaotic communication due to a lack of communication rules,
- open microphones with a lot of background noise,
- lag issues (network),
- poor avatar controlling skills,
- poor moderation skills of the project manager.

These issues resulted in poor motivation of team members, lack of commitment to the project goals and thus difficult team building. Some of the meetings had to be aborted after a short period and their subsequent improvement was assigned to the project manager. A simple process was designed and communicated to team members. As preparation each team member was asked to log into the virtual meeting room and carry out four simple tasks:

1. try out voice communication with another team member using "push-to-talk",

2. give the avatar a personal touch,
3. try to upload a document onto the virtual whiteboard,
4. leave a virtual post-it on the message board stating that you have completed the task successfully.

The project teams had to fulfill these tasks within one week and succeeded without needing further support. As a side task the project teams had to ensure that their internet connectivity would support voice chat without relays at any meeting.

For virtual teams leadership can be an issue. Since poor leadership may result in project team failure, it becomes a much more prominent problem in virtual teams. Inability to communicate with team members effectively can significantly affect a project [6].Therefore, to ensure that good leadership could be established within the project, the project managers were given the power to create their own rules of communication. Most often the project managers chose to moderate the meetings themselves. They would give the right to speak to individual project team members based on requests made beforehand (via text chat). This rule was adopted from common “raid rules” of MMORPGS, which many project team members were quite familiar with. The “raid rules” ensure that only necessary communication takes place during an encounter in an MMORPG. The direct results of this can be summarized as follows:

- focused conversation on topics,
- short meeting time related to the topics scheduled,
- high motivation of project team members,
- committing the project team to a "no-one-gets-left-behind-rule"
- increased commitment to the tool used on the part of critical project team members.

Team Phases

These simple steps all helped to build team trust and team commitment. In order to compare the team building process in the virtual world to one in the real world, the teams were observed and evaluated using the team phases described by *Tuckman* [7].

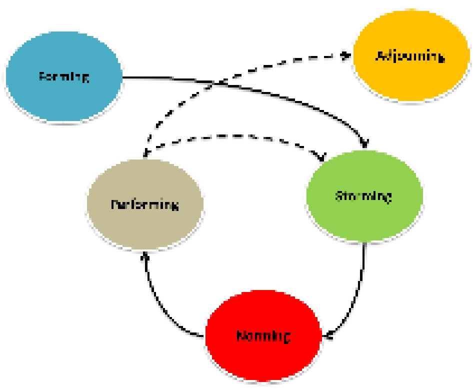

Figure 2. The stages of group development by Tuckman

The following figure illustrates how the different stages were developed by the student project teams. The size of each circle indicates how crucial these stages were to the groups.

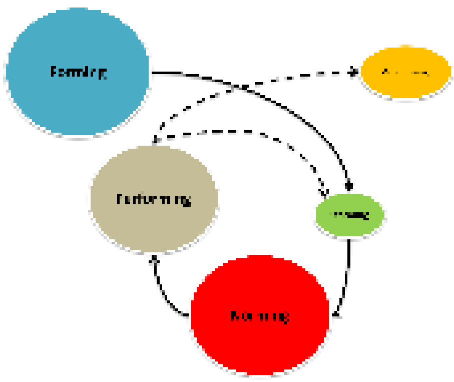

Figure 3. The stages of group development in the project teams

Since team motivation was very high at the beginning, the “forming” stage was crucial. Testing and orientation during this stage were not only important for the team, they were essential for reaching the following stages at all. As a result of the distinct “forming” stage, the “storming” stage was observed as insignificant. The groups did not develop any resistance to group influence and task requirements. In the crucial “forming” stage, however, many emotional response reactions could be observed, which helped to strengthen the team spirit once they were overcome. The use of avatars in the virtual room helped to absorb the emotional distress that occurred when meetings had to be aborted at the beginning of a project. The fact that some project team members were new to virtual rooms and therefore in desperate need of support was respected by those more familiar with the virtual world.

The “norming” stage was assessed to be the most important. During this stage, new standards evolved and new roles were adopted. The "no-one-gets-left-behind-rule" was deployed successfully by most of the teams and helped to maintain a high level of motivation to work on achieving the team's goals. It also guaranteed that none of the team members went into a phase of isolation. The possibility of a team member losing his or her motivation due to being unable to gain "project speed" was highly evident during this stage.

Therefore, the "performing" stage – a stage which does not occur automatically – was easy to achieve for most project teams.

Conclusion

Cultural Aspects have to be considered and evaluated before project start. Since the cultural aspects cannot be changed, the Project Culture itself has to be designed in a suitable manner. This is the most important issue to the project manager. A project team member in the USA, for instance, might be completely used to collaboration in a Virtual Environment, whereas for a project team member in Austria this might be a new and disconcerting way of working. What is true for non-decentralized projects is also fundamental for projects using a virtual environment: Ensuring effective project team communication [8] is essential. Furthermore, it is crucial that communication rules are established by the project manager.

To obtain good project results, every project team member has to understand the goals of the project. Failure to properly communicate can result in frustration and failure of the project team. Using a virtual environment will help to establish effective communication while aiding everyone to get the "big project picture" [9, 140], but it is no guarantee. A simple standardized process like the one described can be implemented to assist with achieving this goal. Only if this issue is resolved can team building take place.

Team Building is crucial to the output of the project team. It also is an ongoing process throughout the project. Therefore, the project manager has to evaluate the team building process regularly. Virtual Environments can help to improve team building in decentralized teams. The main focus areas that can be managed more efficiently in virtual teams than in real life are: Design, Technical, Training, Communication and Coordination. All of these can be addressed in one place: the virtual environment.

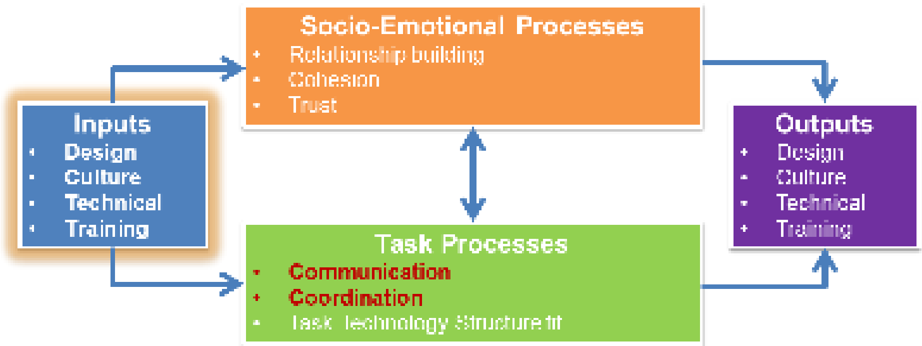

Figure 4. Main focus areas of virtual teams that can be addressed by virtual environments and therefore have a strong impact on the team building process (indicated by the outer glow and the font color).

Compared to decentralized teams, virtual teams working together in a virtual environment do not have to address the following issues [see 1]:

- no possibility of direct feedback
- more individual responsibility necessary

This can be seen as an advantage to those teams collaborating in virtual worlds. Keeping this in mind, we do not need to fear Epicurus' judgment since we know that tools and methods will change, but people will not. All we have to do for now is communicate expectations so teachers as well as students are aware of the problem to solve. *Panta rhei*.

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Using virtual worlds for online role-play

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Abstract. The paper explores the use of virtual worlds to support online role-play as a collaborative activity. This paper describes some of the challenges involved in building online role-play environments in a virtual world and presents some of the ideas being explored by the project in the role-play applications being developed. Finally we explore how this can be used within the context of immersive education and 3D collaborative environments.

Keywords. Virtual worlds, simulations, role-play, collaboration, learning, serious games

1. Introduction

Role-play is regarded as an established technique for engaging individuals in a problem space through a series of structured tasks, which immerse the participants in some of the challenges of the real-world environment [1]. Role-play has been used for many different purposes such as predicting outcomes, war-gaming, team building, and training. It has been particularly useful as a teaching tool in the classroom, allowing students to act out and experience some of the dynamics of a particular problem or issue, from different stakeholder perspectives. Aspects of role-play have also been used in online environments such as virtual theatre, gaming, and focused discussion forums.

The +Spaces [2] project (Positive Spaces – Policy Simulation in Virtual Spaces) explores how virtual world technologies can be used to allow government bodies to measure public opinion on a large scale and maximize the value from prospective policy measures by leveraging the power of virtual world communities [3]. +Spaces is building a range of virtual intelligent environments, varying from polling and debating applications to more advanced role-playing simulation spaces.

This paper describes some of the challenges involved in building online role-play environments in a virtual world and presents some of the ideas being explored by the project in the role-play applications being developed. We conclude that the use of role-play simulations seem to offer many benefits for public policy debate, in terms of providing a generalizable framework for citizens to engage with real issues arising from future policy decisions. Role-plays have been shown to be a useful tool for engaging learners in the complexities of real-world issues, often generating insights, which would not be possible using more conventional techniques.

2. Simulation in virtual worlds

There are several challenges when it comes to modeling the real world in online simulations. For example how easily can we change a person's regular habits? How can we interpret a habit based on predictions arising from a new government policy?

We also need to be clear about what simulations can do that other techniques cannot do. In an online poll the policy maker should know the exact question to be asked. In an online debate such as a chat forum, the question is usually more open but rooted in a core issue. Whereas, in a simulation, the policy maker may not know the exact question to be asked. In a poll users are asked to give a direct answer, in debates users provide more open answers, and in a simulation users may be unaware that they are being asked anything at all.

There is also the danger of the Hawthorne effect – if we force users to behave in a certain way, they will typically start to adapt their behavior – that means that users who participate in simulations are likely to change their opinions about the topic being studied.

A key issue for +Spaces is the lack of a reusable simulation model. Most existing simulations, such as the BBC Climate Change Simulation [4] combine an underlying simulation model (the rules and conditions which affect climate change) with an environment or user interface, which allows users to explore and interact with the simulation online.

Many simulations are also highly complex game playing environments, which have rich graphics, story narratives and game-playing metaphors.

There is also the issue of how to engage with citizens and policy makers using simulations. People generally want to engage with a simulation because they are interested in the topic (such as climate change), or they are enticed by the game-playing or entertainment provided by the simulation (such as Farmville). It is potentially difficult to use these factors in a simulation that has a government policy-making objective.

2.1. Creating simulation models

Edward Castronova [5] has carried out research into economic modeling using virtual worlds. This research has indicated that virtual worlds that exhibit some form of economic behavior often reflect real world economic propositions. For example:

1) That as the price of a good rises, demand for it falls, and
2) If you insert more money into an economy, the price level rises.

This confirms the notion that a virtual world can provide an authentic environment for studying real-world behaviors. However, a common problem with computer-based simulations is the 'black-box' nature of the model that drives the actual simulation. Often the internal model is hidden from the end-user. This is of benefit in terms of improving the overall usability of the interface, but a major weakness for a policy-making application, where the internal rules of the model will make up the framework for the implementation of any new policy. From a policy-making perspective the transparency of the internal model is critical to understanding the factors that will affect the successful or unsuccessful outcome of any new policy. Also by the nature of their implementation (ie. highly complex models) computer-based simulations are often very specific to a particular problem domain and they do not generalize well to more than one problem domain. This makes it very difficult for +Spaces to build a general framework for policy simulation without having to re-implement a different simulation for each policy being considered. This makes computer simulations an infeasible option, as it does not easily support the dissemination and use of the outputs from the project by other parties.

Other experts also back up this analysis. Prof. Richard Duke, author of 'Policy Games for strategic management: pathways to the unknown' [6] is a pioneer of computer based urban simulation games and is President of the International Simulation and Gaming Association. His work has moved away from using simulations precisely because of their black-box nature, to a more general approach based on role-playing simulation exercises that allow different players to engage with each other. Professor Duke believes that this provides a far less deterministic approach, which is more generalizable, and introduces an unpredictable element of human choice into the process (which is a good thing).

2.2. Role-play as a form of simulation

An alternative simulation scenario therefore is to provide a virtual world in which the participants themselves can act out a particular government policy issue through an online role-play activity. This would be a mediated task, facilitated by an online moderator, whereby the users are assigned roles (such as central government policy maker, civil servant, local government agent, citizen) and then asked to act out a particular simulation scenario (such as the implementation of a new waste removal service by private contractors). The role-play could take place in a virtual world that visually recreated the location of the intended policy such as a town hall, or local street.

This type of virtual world simulation is often referred to as a 'serious game'. A serious game is defined as (from Wikipedia):

> *Serious games are designed for the purpose of solving a problem. Although serious games can be entertaining, their main purpose is to train, investigate, or advertise. Sometimes a game will deliberately sacrifice fun and entertainment in order to make a serious point. Whereas video game genres are classified by gameplay, serious games are not a game genre but a category of games with different purposes. This category includes educational games and advergames, political games, or evangelical games. The category of serious games for training is also known as "game-learning".*

Serious games are often used where it would be too dangerous or too costly to attempt the activity in a real-world setting. Examples include safety training on oilrigs and war-gaming exercises. In both of these examples, the keys factors are:

- A realistic virtual world environment (reflecting the real world)
- Multi-player scenarios and collaboration, often with users role-playing different characters (such as paramedic, doctor, patient)
- A rich underlying model reflecting the real-world behaviors available (such as fire fighting capabilities on an oil rig)

The creation of a serious game simulation will often have the same issues as identified for other complex simulations (as discussed above). However, there are some open source tools, which could be used to create a serious game policy making simulation. For example PIVOTE [7] is authoring system for learning in virtual worlds.

Created by Daden originally for the JISC funded PREVIEW project, PIVOTE is now an open-source project and available for free download and use by anyone.

PIVOTE supports:

- Creation of learning exercises on the web using a simple forms based interface
- Creation of objects in a virtual world such as Second Life, which users can use to interact with the exercise
- Playing the exercise in Second Life, OpenSim, or on the web or even an iPhone.
- Porting exercises between virtual worlds
- Sharing PIVOTE compatible objects between exercises and institutions
- Rapidly editing exercises to create variations, or custom versions for different skill levels
- Exporting student performance data for us in an online learning environment

Using PIVOTE it would be possible to create a forms-based interface to allow policy makers to input the content for a simulation scenario. This could then be translated to a web-service, which can be interfaced to a range of front-ends, including Second Life, Open Wonderland, and the web (such as a Facebook page). PIVOTE also supports in-world chatbots, which can be used to structure the simulation dialogue with the human participants.

The role-play simulation could then be followed up by an online poll and debate using the other +Spaces applications, to elicit further information about the implications of the new policy initiative.

3. +Spaces role-play simulations

The +Spaces project is building on these ideas to create both 2-dimensional (web-based) and 3-dimensional (virtual world) environments to support synchronous role-playing simulation events. We have already created a 3D polling environment and a virtual debating chamber, which have been evaluated in a series of field trials (to be published). The 3D role-playing tools and applications will represent the final and most challenging aspect of the project.

The project has been exploring the use of role-play templates to help policy makers devise an appropriate role-play simulation to support a given policy issue. The following are examples of role-play templates that have so far been developed:

- Galactic wormhole: participants imagine themselves to be five years in the future and reflect on positive and negative outcomes of a particular strategy
- Depolarizer: structured game based on the philosophy that many issues that we treat as problems to be solved are actually polarities to be managed

The 3D environment will be implemented on Open Wonderland [8]. So far the project has developed the following new modules that extend the functionality of the Open Wonderland platform:

- Office-converter - enables drag-and-drop of office documents into Wonderland
- Twitter-viewer - module to search and display twitter micro blogging posts animated in world

- VNC control webapp, Webcam control webapp and Poster control webapp - modules to edit the VNC, webcam and poster cells respectively

A role-playing session on Open Wonderland will be initiated by a +Spaces scheduler, based on the time stated by the policy maker upon creation of a role-playing experiment.

The Open Wonderland role-playing chamber will clearly display the current phase of the role-playing simulation session as well as the current topic. It will also display the participant's own role to other participants.

Users will also have an opportunity to prepare reasoned arguments or vignettes based on an assigned character role or perspective. When quiet thinking time is over and users are ready to contribute their input, Open Wonderland will provide colour-coded post-its, on which participants will write their input, and which can be placed onto a 2D board.

A separate 2D asynchronous role-playing simulation will be implemented in Twitter. Participants will be invited to take part via their tweets – be that for open discussion or for contributing their structured input.

A role-playing session on Twitter will be initiated by the +Spaces platform upon the creation of a role-playing simulation experiment by a policy maker. Participants will be able to follow the session and participate through their regular Twitter use (Twitter page or a browser add-on), or through the +Spaces Twitter role-playing application page, where they will be able to follow the structure of the session, and where their responses will be automatically wrapped with the relevant and required hashtags.

The +Spaces Twitter Role-Playing Application will also summarize the session, and it will clearly display the current phase of the role-playing session; display an aggregation of the participants' responses; and display the user's own role in the session, and clarify the type of required response.

We are currently in the process of building the following Open Wonderland modules to support the +Spaces role-play application:

- Templates, users and roles
- Role-Play Banner
- Poll results and final results
- Clustered Post-its
- Poll carpet with 9 segments
- Heads Up Display (HUD)
- Role assigner
- Clock countdown timer

4. Implications for immersive education

The tools being developed by the +Spaces project to support online collaborative role-play can also be used in classroom based learning activities. Simulations have long been used to support constructivist-learning tasks, particularly based around participatory models of learning [9]. However, the 'black-box' nature of these simulation models is recognized as a limitation in their use for teaching and learning. Students can often get frustrated by the hidden nature of the underlying simulation models. There is also evidence that it can result in '*superficial understanding'*, or '*factually wrong conclusions*' about the topic [10]. Contributory, 'glass-box' based approaches to discovery learning are therefore encouraged. The +Spaces role-play tools also take this approach. By facilitating online role-plays, we envisage that students can go beyond the superficial understanding of complex topics, to become more engaged with and ultimately achieve a better understanding of the subject matter. This is combined with the use of 3D virtual environments, in which we hope to provide highly engaging immersive collaborative spaces for teaching and learning to take place.

5. Conclusion

The innovation for +Spaces is in the application of role-playing as a simulation tool for policy makers. Many of the challenges for the project are shared with immersive education:

- How to support online participants across different platforms
- How to define a role-play and then select users and schedule (and setup) the event
- Managing the structured role-play
- Capturing the results from the role-play
- Analyzing the results to support assessment (eg. for policy making)

The benefits of using a role-play simulation for the +Spaces project are that it supports the need for interoperability across platforms (Facebook, Twitter, Blogger, Wonderland), across +Spaces applications (polls, debates, simulation), and with other core +Spaces services (a recommender/reputation system for selecting participants and a data analysis service).

It will also provide rich data sets for the analysis systems in terms of the role-play dialog and events, and it should provide a more generalizable policy simulation framework.

The project is currently building several role-playing applications, which will then be evaluated in a series of online trials. We envisage that the +Spaces role-play tools can also be used to support classroom-based discovery learning activities, and is highly relevant to the field of immersive education. We hope to further report on the outcomes from these trials (and the implications for collaborative role-play using virtual worlds), in future presentations.

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Artistic collaborative creation and education in virtual world

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Abstract. This article present an experimentation of artistic collaborative education in virtual world created by Raphaël Isdant and Nicolas Sordello, and produced by Art dans la Cité with in partnership

Keywords. Virtual worlds, arts, collaboration, learning

1. Introduction

Massive interaction in shared space online open, for first time, the possibility to feel intuitively the three dimensions of digital spaces. By offering this shared perception of space, virtual worlds have become one of the first manifestations of the emergence of a new artistic medium, a medium space.

Get a new artistic dimension is a rare event in art history. The last was the appearance of time in the image. Moving picture film and television have radically transformed our understanding of the world in 20 th century.

This new medium disrupts our spatial relationship to the world and updates fundamental philosophical issues (reality, identity, places). We need to understand the features, the new uses and the aesthetic impact of this new médium.

Since 2007, the research program ENER de l'Ecole Nationale des arts décoratifs de Paris, aims to explore the new artistic fields open by this space medium, and to facilitate the use of these new territories in the areas of research and learning in the arts.

This paper present an experimentation of artistic collaborative education in virtual world created by Raphaël Isdant and Nicolas Sordello, and produced by Art dans la Cité with in partnership with the Ecole Nationale Supérieure des Arts Décoratifs (ENSAD) and its research laboratory EnsadLab/ENER.

2. A window into the Room

A Window into the Room is a multimedia installation and workshop developed with young patients confined to the challenging and sensitive environment of a sterile isolation room. First imagined and created for the hematology wing at Armand Trousseau hospital in Paris, France, this project allows children to explore new digital tools for creating their own virtual world as members of a community, to break out of their isolation and to bring their world alive on the walls of the adjoining family room.

<u>*Goals of the project :*</u>

1) Pilot an innovative system for enabling multimedia creation and collaboration between children as part of a community.
2) Allow the children to meet and share their hospital experiences virtually.
3) Provide a unique tool for communication among the children, and also with their parents and the outside world.
4) Encourage the children to think about exhibiting their works to others.
5) Introduce them to 3D modeling tools helping them to better understand spatial relations and dynamics.

A Window into the Room comes to life in 2 spaces simultaneously:

-Through workshops in the isolation rooms

At the heart of this project is a virtual world accessed through the internet on a laptop present in each child's room. This world takes the form of an undeveloped island which the children explore through a self-created avatar. They are the creators of living, animated, autonomous constructions, the builders of cities and play spaces where they can meet and exchange.

Structure of the workshops : *personalization of an avatar, exploration of the virtual world and its potential, taking hold of the multimedia creation and communication tools, and creating content.*

Technical aspects : *Software installed on the children's computers allows them to connect to the open source server of the virtual world, Opensimulator. This world is hosted by Francogrid and its maintenance is performed by EnsadLab and Pôle ENER, partners in the project.*

Through an interactive window in the parents' room

A video-projection system on the wall of the parents' room opens an interactive window into the children's virtual world. This setup makes it possible to observe and even interact in real time with the workshops taking place in the children's rooms. This window is thus a unique means of communicating with the children while allowing them to share their creativity.

Technical aspects: *a wireless keyboard allows family and friends to chat with the children and explore the Island. The window in the parents' room can also be closed to preserve privacy when needed.*

Project participants :

This project was created by Raphaël Isdant and Nicolas Sordello, and produced by Art dans la Cité with the help of the Ecole Nationale Supérieure des Arts Décoratifs (ENSAD) and its research laboratory EnsadLab, and of FrancoGrid. It is supported by the Fondation de France, the Direction Régionale des Affaires Culturelles, the Agence Régionale de Santé d'Ile-de-France and GlaxoSmithKline. Art dans la Cité worked closely with the hematology wing and the communication department of Armand Trousseau Hospital, and collaborated with Margherita Balzerani, new media art curator and critic.

Link:

Fenetre sur chambre:http://fenetresurchambre.blogspot.com/p/presentation.html
Ener/EnsadLab: http://ener.ensad.fr/

Computer Assisted Assessment within 3D Virtual Worlds

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Abstract. 3D Virtual Worlds are currently been explored as learning environments due to their capabilities to promote learner motivation. Most of the research has been focused on the deployment of learning strategies on them. However, a crucial component of the teaching-learning process: the assessment has been neglected. In this work, we present an architecture that integrates an engine QTI-compliant with a 3D virtual world platform. The rich set of interactions that can occur in a 3D virtual environment is mapped onto the 2D format of the QTI-specification. As result, our solution allows a computer assisted assessment into a 3D virtual world using metaphors adapted to this rich interface. We present an assessment experience deployed on our architecture. The results of the evaluation show satisfaction of learners in using test assessment questions within 3DVWs and improvement in learning outcomes.

Keywords. Assessment, 3D Virtual Worlds, QTI Specification

Introduction

The new generation of learners, the so-called *digital natives*, demands a more active learned-based approach that goes beyond just memorizing facts or understanding concepts [1]. On the other hand, technology-based environments can take advantage of different patterns of work, attention, and learning preferences of these *digital natives* [2, 3, 4]. Among technology-based environments, 3D Virtual Worlds (3DVW) stand out for their capabilities of immersion and interaction that foster student motivation [5, 6]. Thanks to recent advances in hardware performance and open source platforms such as OpenSimulator [7], Open-Cobalt [8] and Open Wonderland [9], 3DVWs are starting to be used as learning environments. Initial experiences focus on 3D simulations, organization of public events and collaborative activities [10].

We claim that the success of 3DVWs on education is tied to the development of authoring tools that facilitate the deployment of learning activities, the integration of eLearning technology to these environments and improvements on visualization and performance. In this work, we focus on the integration of eLearning technology for students' assessment on 3DVWs. We are particularly careful on taking advantage of the immersive and interactive possibilities of these learning environments.

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This paper is organized as follows. Next section is devoted to related work on 3DVWs and eLearning assessment technologies, the two technologies to be integrated. Section 2 examines interaction patterns on 3DVWs and how can be mapped to classical question items used on automated assessment tools. Section 3 shows the architecture that supports the integration of a QTI engine (NewApis [11]) to a 3D distributed game-based platform (Open Wonderland [9]). Section 4 presents an extracurricular learning activity carried out among graduate engineering students. The learning activity is deployed on a 3D simulated setting of the science fiction novel "The Invention of Morel" by A. Bioy Casares [12]. The aim of the experience is to provide formative assessment using the architecture presented. Finally, conclusions and future work are discussed in Section 5.

1. Related Work

1.1. 3D Virtual Worlds

3D Virtual Worlds can be seen as a multimodal user interface where 3D scenarios are filled with 3D objects that can be explored through avatars. 3D objects can be the representation of real or fictional objects with interactive possibilities or non-player characters (NPCs) that can act on plausible ways. 3DVWs have the same multimodal capabilities as web-based interfaces: text, images, audio and video that are proved useful to transmit knowledge [13, 14]. Additionally, they provide a new way to explore content through interactivity: the interaction that avatars can have both with 3D objects and among themselves [15, 16]. In education, the first type of interaction is useful for training and simulation, the second for collaborative activities and awareness [17].

3DVWs allow deploying truly immersive spaces fostering learner's imagination with possibilities of interaction with the environment, the objects and other community members through avatars [5, 18, 19, 20]. They offer an excellent place for learning and teaching and some authors have issued guidelines for using several learning strategies such as situated learning, role playing, cooperative-collaborative learning and problem-based learning on 3DVWs [5, 6, 21]. The principles stated suggest the use of visual elements of 3DVWs to immerse students into a situation where the problem to be solved is presented in a natural way. Besides, 3D objects and non-player characters (NPCs) are used as instruments to transmit information and as tools to build knowledge as it is required by constructivist principles [22].

First attempts to introduce assessment on 3DVWs have been done on serious games where studies highlights the importance of do not break the *flow* state induced by immersive games with invasive assessment activities [23, 24]. In this sense, V. J. Shute's work [23] uses Bayesian models to monitor actions, integrate evidence on learner's performance, and update the student model in relation to competencies. In River City [25], a multi-user virtual environment, the detailed records of students' actions are collected and stored to assess how learners detect and decipher pattern of illnesses in a town besieged with health problems. Studies found on edutainment deals with tools made *ad hoc* with no possibilities of interoperability.

QuizHUD [26] represents the first attempt to integrate a computer assisted assessment tool to a 3D virtual world. QuizHUD includes both classical multiple choice and exploration questions. Classical multiple choice questions are included into the virtual world as it would be in a web-based learning environment. For the exploration questions, students should click on 3D objects to state their choice. Our work follows the exploration questions approach and extended it by using a richer set of interactions within the 3D learning environment.

1.2. E-Learning Assessment Technologies

One of the assessment instruments most used in Computer Assisted Assessment (CAA) are the so-called objective tests. The main advantages of these tests are: improvement of the interactivity with the learning contents and the automatic presentation of questions, responses and provision of marks and feedback [27]. One of the main concerns in this field is to align assessment activities with the objectives of the educational curriculums in order to assess a variety of skills [28]. However, the traditional use of questions such as Multiple Choice, Multiple Response or Fill in the blank, doesn't support well the assessment of higher-order skills such as: problem solving, exploration, spatial or time perception skills, among others. Generally, the use of traditional type of questions is lack of complexity [29]. As a consequence the resulted tests are not adequately for capturing the goals of an educational curriculum [28, 30].

Different researchers claim that the use of Information and Communication Technologies (ICT) enables the design of new assessment types of questions and tests, allowing the creation of more complex CAA scenarios adapted to real life tasks. Conole & Warbuton [31] stated that increasing the interaction possibilities between students and questions enhances the students' participation in the assessment process. On the other hand, [32] indicated that the addition of multimedia resources in the creation of questions helps the teacher to assess more tasks. As a consequence, the more technological resources you use, the higher skills and more sophisticated tasks can be evaluated [33].

Another concern of the CAA field is to represent computationally the tests in order to support its automatic interpretation by software tools. Educational technology specifications for assessment provide formalizations to represent the information of objective tests. Especially, the IMS Question & Test Interoperability (QTI) is the de-facto standard to represent question-items, tests and assessment results [34, 35, 36]. QTI is easy of managing because its XML building and its support re-usability, adaptability, scalability, and interoperability with other languages, specifications (e.g. IMS Learning Design [37]) and systems. QTI supports question-items involving graphical interactions, such as hot spot or select point, among others. Although, QTI does not address interactions adapted to specific educational goals, thanks to the flexibility of its Information Model a valid solution to the integration of interactive media can be based on QTI. However, there is lack of significant examples and efforts showing the possibilities of QTI for advanced CAA [38, 39]. In order to manage the information contained in the QTI tests an engine has to be used. The engine assesses automatically the responses and provides feedback [35].

Although, there are few examples that show how to use QTI to implement advanced CAA scenarios, it is a relevant candidate to computationally represent CAA within 3D virtual worlds because the formalization and interoperability prospects that it provides. In this approach the NewApis engine [40] compliant with QTI v2.1 has been selected to manage the QTI-Wonderland interactions proposed [41].

2. Interaction Patterns on 3D Virtual Worlds

IMS-QTI (Question and Test Interoperability) is an interoperable assessment specification that has been used to evaluate knowledge in traditional Learning Management Systems. The assessment tests are composed of a set of questions with a pre-determined correct answer and possibly also a feedback and a grading scheme. Although the specification works with several types of questions: multiple choice, multiple response, true/false, fill-in-the-black and more, we focus our work in multiple-choice. A multiple-choice question specification consists of the following parts:

1. A prompt to provide the question to students.
2. A response template with the list of choices.
3. A correct response.
4. Feedback and grades for different options.

Elements (1), (2) and (4) are related to information that a Learning Management System (LMS) must transmit to the students whereas element (3) corresponds to the information that student must provide to the LMS.

Students are immersed in the 3DVW therefore perceive and act through their avatars. Perception comes from the senses of hearing and sight and can be very real in a 3D immersive system that can be explored freely. Although is technologically feasible, the haptic perception is not typically included in 3D virtual environments. On the other hand, the LMS can monitor and log any interaction carried out by avatars within the virtual environment in order to interpret any student answer.

2.1 Interaction of the Learning Management System with Students

3DVWs can transmit visual information to users through text, pictures, 3D objects and the 3D scenario where it is deployed. Audio information usually is transmitted in combination with visual information through video or actions carried out by 3D objects (including NPCs).

Prompt can be available to users through different ways:

- Text as it is usually done in a class or a web-based learning environment.
- Audio or video file.
- Dialogues and actions performed by one or more NPCs can transmit the question to learners.

It is also possible to adapt the system to students´ preferences for receiving information. Besides, mechanisms should be provided to replay the information as many times as necessary for its full understanding.

Once students have received the question, a list of choices is available for them:

- The 3D objects within the virtual world which includes NPCs.
- The set of different places of the virtual world.

Feedback can be received in the same way as the prompt. A feedback can also be the change of the 3D scenario or its elements. For instance, a correct answer to a question may imply that a song starts playing or a 3D object that represents a prize to appear or student's avatar is teleported to another place of the virtual world. Even a correct answer might imply the occurrence of all these actions simultaneously.

2.2 Interactions of the Students with the Learning Management System

Avatars can perform a rich variety of actions that can be monitored by the system and thus can be interpreted as the answer of a question:

- Displacement from one place to another either walking, running or via teleporting. The information to transmit can be either the destination point, the proximity to an object or the path followed. The time employed can also be registered.
- Perform gestures to affirm, deny, waving, clapping and so on. Gestures represent a way of communication that has not been yet employed on traditional assessment.
- 3D object manipulation which includes the selection an object, the displacement of the object, the modification of its size or any kind of simulation.
- Interaction with NPCs. NPCs can have simple conversations with students thanks to the AIML programming language [42]. An AIML program is a XML script which relates linguistic patterns: the input pattern will be provided by the student via text and the output pattern will be performed by the NPC via audio. Thus, students might answer a question via text interacting with an NPC.

3. Architecture

Our proposed architecture, shown at Figure 1, is based on Open Wonderland (OWL) [9], a Java open source Multi User Virtual Environment toolkit with functionality that can be extended by adding or modifying modules (plug-ins). Open Wonderland is a client-server architecture where game-based functionalities are divided among client and server. Our architecture extends the Open Wonderland with capabilities to deploy assessment activities into the 3DVW, monitors interactions related with these activities within the virtual world, and reports them to a QTI-compliant engine (NewApis [11]). Whereas, NewApis provides the questions to be deployed into the 3DVW; evaluates the students´ answers; deploys the feedback onto Open Wonderland and finally, computes the students’ grades.

3.1. Test preparation

NewApis has been extended to deal not only with QTI v2.1 XML files describing tests to play onto a web-based environment, but also to deal with tests to be deployed and played onto OWL as assessment environment. A new OWL-QTI XML type of file has been developed to include the new possibilities offered by 3D virtual learning environments. The specification of the different parts of a question includes the resources required, the students’ events that activate actions into the 3DVW and the new events produced as result of an action. The description of the resources and events that might occur during the enactment of a question is stored into the OWL-server.

Resources are 3D objects that filled the 3D environment. For instance, a 3D model, an NPC, an image, an audio file, a pdf file. These 3D objects can be built with different tools: SketchUp [43] for 3D models, Evolver [44] for NPCs, OpenOffice [45] for a power-point document and import them directly into an Open Wonderland virtual world. The OWL-QTI XML file identifies the resources through a path followed by its identifier.

A behavior (action) can be associated to a resource and it is activated when an event occurs. Examples of events are: click-on an object, approaching or leaving an object, arrive to an area, move an object. Actions that can be associated to an event can be the appearance or disappearance of an object, the displacement of an object and the play of a dialogue among NPCs.

A test for NewApis with multiple-choice questions QTI-compliant is created by the teacher and then extended with information about resources, events and actions. The extended test is stored onto the OWL QTI-XML server's database. The OWL-server sends to the OWL-clients the extended test through its High Level Orchestration Module and the execution starts. During execution, each OWL-client must synchronize its actions with NewApis.

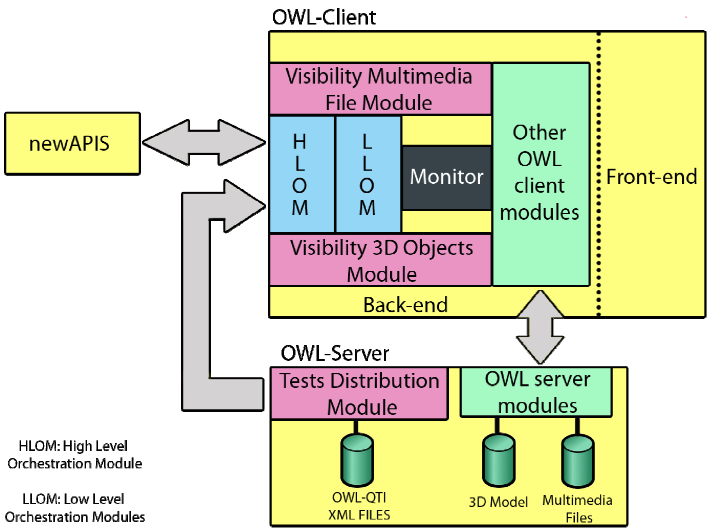

Figure 1. Architecture of a Computer Assisted Assessment System within 3D Virtual Worlds.

3.2. Two levels of orchestration of activities

Our assessment system will allow students to solve the questions of the tests at any order. This high level orchestration will be carried out guided by Open Wonderland. A list with the places in the virtual world where the test questions must be asked is available to students in real time. OWL-client through its High Level Orchestration Module will maintain actualized the list of non-answered questions for each student whereas NewApis records the questions answered. Additionally, for any question remaining to be answered, students will be instructed about which actions must be done to cause the enactment of each of these questions.

Once a student chose the new question to answer, the OWL-client through its Low Level Orchestration Module (see Figure 1) will be in charged of a low level of orchestration that organizes the different steps involved in the question: statement presentation, choices presentation, monitoring of student answers, feedback and evaluation. Each question has a set of resources associated (3D objects, NPCs, images, audios, texts and so on) that belong to one or more of these steps. The resources must appear in the right order and depending on the actions performed by the students. Visibility Multimedia File and Visibility 3D Object modules are in charged of hide or unhide multimedia or 3D object resources respectively (see Figure 1). Once the OWL-client captures the student's answer, it must send this information to NewApis. Then, NewApis will compute the score of the answer and sends to OWL-client information about which feedback to provide.

For instance, from left to right and top to bottom, Figure 2 shows the orchestration of a question of a test. First a student reads a text with the question to answer: "Which country won the last FIFA World Cup?". The text disappears and then three different options become visible to the student: three NPC, each one dressed with the uniform of a different country: Italy, Brazil and Spain. To answer the question, the student should approach one of the players; the system will capture this action. Finally, the student approach to Spain player and the picture of the final ceremony appears as final feedback: our student answered correctly the question posed.

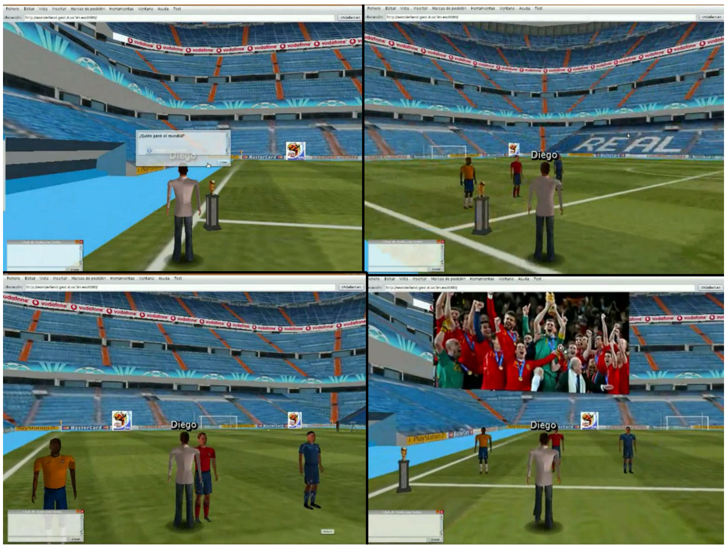

Figure 2. Low level orchestration.

3.3. Monitoring avatar actions

Once orchestration determines that student is going to answer a question, the Monitor Module (see Figure 1) registers the actions taken by the avatar, analyze them and choose one that matches with one of the options expected. The Monitor Module identifies the question option chosen by the avatar and sends this information to NewApis.

4. Case Study

We present a case study based on an extra-curricular learning activity carried out by twelve graduate engineering students (age 26-31, 5 females and 7 males) at the Universidad Carlos III de Madrid. The learning activity was deployed on a 3D simulated setting of the science fiction novel "The Invention of Morel" by A. Bioy Casares[12] in two session of work, each with half of the students and supervised by three instructors. To this end, a discrete representation of the island where the actions of the novel takes place was built with the open-source toolkit Open Wonderland [9].

The purpose of the experiment here described was twofold: first, to determine the degree of physical and psychological immersion that participants could feel in the 3D virtual island and second, to explore the capabilities of 3DVWs as assessment learning environment.

After reading and discussing the novel in a face-to-face learning session, students logged into our 3D virtual representation of the island and followed several assessment activities. During the tour through the island, participants had to identify some of the characters of the novel based on their appearance, the place where they used to act or the dialogues performed. In order to answer some questions, participants had to choose the right object for a character or they had to go to a location where an event had happened. These situations covered the different types of interactions that a user can experiment in a 3DVW.

The study included a quantitative analysis of a questionnaire of 20 questions with 5-point Likert-scale items that participants filled just after the assessment experience in the 3DVW. Finally, qualitative data was collected conducting post-experience interviews. In the interviews, participants were asked about their perceptions, opinions and attitudes toward the 3DVW as assessment learning environment.

4.1. Results

The questionnaire had three questions related with physical immersion into the 3DVW and one with psychological immersion. 69.5% of the answers revealed that participants usually or always felt the sense of physical immersion; meanwhile the psychological immersion feeling was achieved only by half of participants. During the discussion session, participants highlighted the 3D audio features of Open Wonderland to create the sense of physical immersion along with the possibilities to explore the environment from the point of view of their avatar. They mentioned two main focus of concentration disruption: unappealing 3D objects and some technical problems that appeared during the experience.

In terms of usability, 75% of answers reported that participants seldom or never had difficulties of interaction within the 3DVW. Only 6.3% of participants revealed to have some problems interacting with 3D objects. However, 38% of answers indicate that participants had troubles to identify the objects with interactive capabilities. Finally, 51% of participants found very useful to receive information through several information channels.

Participants reported to be strongly (41.7%) or very (58.3%) motivated to answer the test within the 3D virtual world. 70.8% of the answers indicate that the assessment within the 3DVW helped them to understand better the novel. Furthermore, 58.7% of participants preferred this kind of assessment over traditional ones. In the discussion session, participants claimed for more textual feedback to help them to recover in case or errors. They strongly suggested presenting the test as a narrative story in order to improve the immersion on the assessment activity. They highlighted the potential of these environments for formative assessment and asked for 3DVWs possibilities as skill assessment environments. Despite the experience was conceived as an individual assessment activity, participants asked for collaborative assessment activities within the 3DVW.

4.2. Discussion

The results show satisfaction of learners in using test assessment questions within 3DVWs. Assessment activities enhanced learners motivation and were helpful for a better comprehension of the topic examined.

The 3D virtual world was especially useful to promote physical immersion. However, the psychological immersion was disrupted by the 3D aesthetic models and some technical problems tied to collision between objects.

Finally, participants remarked the capabilities of 3DVW as formative assessment environments, suggested the introduction of a story to lead students through the different exam questions and demanded the introduction of collaborative activities within the test.

5. Conclusions and Future Work

In this work we have integrated a QTI-based engine originally developed to be used in web-based learning environments into an immersive learning environment where students have the possibility to interact with 3D objects. This integration has opened the possibility to automate assessment of knowledge in 3DVWs exploiting all the sensorial capabilities of this novel interface. The orchestration facilities included into the architecture, allowed a flexible way of work to the students preserving the freedom offered by virtual worlds. We limited our work to multiple-choice questions, but we expect to include other types of questions on the near future.

An assessment learning environment has been depoyed and used by a small group of graduate students to determine the engagement possibilities to 3DVWs and to explore the capabilities of 3DVWs as assessment learning environment. Results prove that immersion is achieved but should be improved by using more refined 3D models and introducing more realistic physical effects. Students were able to do the test with no difficulty and suggested the use of collaborative activities and the introduction of orchestration at narrative level.

Although we have used 3DVWs to assess knowledge using IMS-QTI, these virtual environments offer the possibility of skill assessment thanks to their capabilities of simulation and monitoring events. We are currently exploring these 3DVWs assessment capabilities.

In our opinion, the success of 3DVWs as learning environments is highly tied to the availability of 3DVW authoring tools that address both artwork and narrative. On the one hand, the need of producing visually appealing scenarios has been claimed by participants in our learning experience. On the other hand, the deployment of activities including characters, dialogues and actions is not only costly in time but also difficult to reuse. These drawbacks can discourage instructors to use these worlds as assessment learning environments.

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Further explorations on Supporting Learning in Virtual Worlds with Web-Based Learning Environments

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Abstract. This paper reports on the outcomes from the JISC LTIG Project "Supporting Learning in Virtual Worlds with Virtual Learning Environments". With pilot studies across four universities in engineering, computing science and medicine, and with pilot groups using virtual worlds to support learning through simulation, informal discussion groups and through clinical role-play, the project was able to explore a range of the different ways in which web-based learning environments can be used to support learning in virtual worlds. At the most basic level, a web-based VLE can be used to provide structured guidance and scaffolding for a range of activities in a 3D virtual world. Beyond this, it is also possible to bring web-content directly into a 3D environment – presenting interactive web-pages on surfaces in the environment or attached directly to user avatars. This may be used to create a more immediate connection between the online guidance and the inworld learning activities. The project also further explored the use of SLOODLE, which provides more explicit connections between a 3D environment (currently either Second Life or OpenSim) and a web-based VLE (Moodle). SLOODLE provides a range of tools and features that make explicit integration of the web and 3D environments possible – from basic features such as connecting student avatar and web identities, to supporting web-based authoring of quizzes to be embedded in a 3D environment. Additionally, a set of resources for practitioners was produced and released.

Keywords. Educational Software, Blended Learning, Student Assessment, Virtual Worlds, VLE, SLOODLE

Introduction

Although Virtual Worlds, VW, including text-based VW, have been used in education for many years [1], rapid growth in the use of graphical VW during the middle of the last decade led to numerous projects seeking to explore how they might be used in education, c.f. [2,3]. But for the most part studies do not consider in any great depth the relationship between VW and web-based learning technologies – with some notable exceptions. In their exploration of the technological possibilities of learning with VW, Livingstone & Kemp [2] compared the features of one 3D VW, Second Life (SL), with those features typical of a web-based VLE or LMS, followed by their first investigations of how VW and VLE might be more formally integrated [4].

Studies and projects using the Active Worlds, AW, platform often make more reference to web-based content, and how this may be used to support learning - this is attributable to the design of AW itself which uses several panes of information for interacting with the virtual worlds - one of these being a built-in web-browser. Accordingly, in a study of the affordances of the platform for supporting teaching and learning [5], the presentation of supporting web-content is discussed. The ability to link the presented web-content to current activity in the 3D environment is also actively exploited in both the River City Project [6] and Quest Atlantis [7]. In the latter two examples, the web-content is customised for use as a game interface, with support for awarding and tracking quests and missions and for use as an in-game notebook.

A wide range of other VW allow web-based content to be viewed directly inside the 3D environment - Teleplace, Open Wonderland, SL and OpenSim all allow viewing and interacting with web-pages in the 3D environment. Other platforms, such as Kaneva, allow the embedding of specific web-content such as YouTube onto screens in the 3D space. Other virtual worlds (more commonly 2D or isometric) can be run inside web-browsers. Now closed, Metaplace was an example of a 2D VW which could be embedded into any web-page - including within a VLE.

Finally, a range of 2D and 3D virtual worlds provide scripting interfaces that allow developers to create their own links between the VW and other internet based resources. The ability to script objects in SL and to extend the open source Moodle VLE was exploited by SLOODLE to share data between the VW and the VLE.

Despite the range of ways in which web and 3D content can be integrated or combined to support teaching and learning, there has been limited work in exploring how best to use web-based VLEs to support teaching and learning in virtual worlds. Given the great variety of ways in which they may be used together, this oversight needs addressed - and this was the core concern of the recent JISC LTIG project: Supporting Learning in VW with VLE. In the remainder of this paper we explore some of the ways in which VLEs can be used to support teaching and learning in VW, building on our recent project experiences. While not exhaustive, this effectively illustrates that there exists a wide range of ways in which existing web-technologies may be adapted to support learning in virtual worlds.
The project also created a set of resources to aid practitioners in understanding possible benefits, processes and resources required to create VLE supported learning activities in VW. The resources are available from the project website (see acknowledgements).

1. Web-Based Guidance for Scaffolding VW Activities

1.1. Using a VLE to provide initial instructions and guidance

The most basic use of a VLE to support learning in a VW, is through providing scaffolding for learning activities in providing instructions and guidance for students to help prepare them for the VW, and to help them complete tasks in the world.

Basic steps would include providing instructions for students, and providing specific guidance on launching the VW software and on how to begin a particular activity. If using SL, it is possible to provide SLurls – URLs which hyperlink to specific locations in SL via an intermediary Linden Lab hosted web-page. While this might seem straight-forward, in our pilot we found that even this basic step could prove troublesome. Encountering the link would cause them to launch into the VW and they would often forget to refer back to the web-page for further instructions, resulting in instructions below a link being ignored.

1.2. Hyper-linking to the Virtual World

We additionally found an unexpected issue with the use of the Linden Lab SLurl system. When copying a link to a SL location directly from the client software, a URL is created that uses the maps.secondlife.com domain, e.g.:

http://maps.secondlife.com/secondlife/Ulster%20Magee%203/94/242/23

This in turn links to the page shown in Figure 1. This has a confusing page layout with many images and page elements jostling for the user's attention. Several students got stuck on this page for several minutes, and needed instructor support to find the correct 'Visit this Location' link. A simple, though non-obvious, solution to this problem is to use an older SLurl service that is still maintained by Linden Lab, and hosted on the slurl.com domain. The pages created using this service are significantly simpler, and students found no problems using this SLurl service, and no tutor interventions were required to help students access the VW from here.

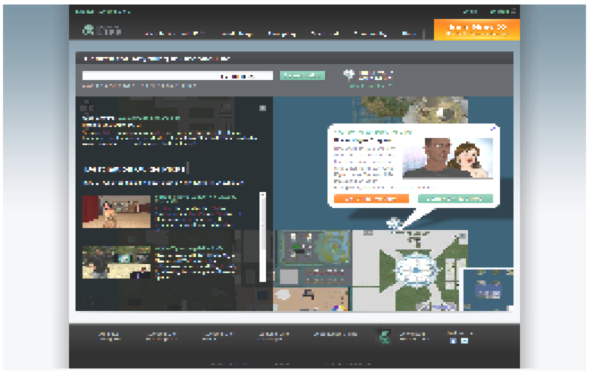

Figure 1. SLurls copied from Second Life direct users to a visually confusing and distracting webpage. Users with no previous experience of Second Life found this particularly challenging when first encountered.

SLurls link to web-pages on the Linden Lab servers which, in turn, provide links for launching and accessing SL. The link that launches SL is similar in appearance to, but is not a URL, e.g. secondlife://Ulster%20Magee%203/94/242/23. Notably the second part of the link (after ://) should indicate a unique internet address – including IP address or domain name, but has neither. An alternative method, OSurl, for linking to OpenSim locations has been created and this does separate out the protocol from the internet address of the VW being connected to. However, this still requires a user to install additional software to launch the VW client.

In contrast, the Open Wonderland platform is built on Java – a standard web-technology, supported by all major web-browsers – and supports direct linking to specific locations in the VW without the need to install additional software.

2. Integrating VLE & VW with SLOODLE

Further opportunities to use a VLE to support learning in VW emerge when the two environments are integrated to allow the transfer of data directly between the two. SLOODLE plug-ins for Moodle and SL or OpenSim do precisely this - allowing the transfer of identity and activity data between web and 3D environments. The features of SLOODLE have been detailed elsewhere [8], here we consider only some of the key applications of SLOODLE for supporting learning in the VW.

2.1. VLE as a VW Activity Authoring Tool

One possible use of a VLE is as an authoring tool, to simplify the creation of new activities in the VW. Creating the 3D content itself is not something the VLE can help with - but information displays in the VW can be created from pages on the VLE, and SLOODLE allows quizzes and polls authored and stored in Moodle to be embedded into 3D environments in Second Life and OpenSim [8].

2.2. Integration for Tracking, Analytics and eAssessment support

Using the SLOODLE Quiz Tool brings Moodle quizzes directly into the VW - and automatically records responses and updates the gradebook on Moodle. A useful tool for summative and formative assessments taken at key points during some VW activity - but what about tracking student progress more generally?

Analytics can help students monitor their own progress, and help tutors understand where students are having difficulties and might need additional support. The SLOODLE Tracker, developed at the University of Ulster, supports exactly this - and can be set up to track when students interact with specific items.

The Tracker also allows students to review their own progress, to check whether they have successfully completed tasks set. In the trial of the Tracker at the University of the West of Scotland, it was found that most students did not refer back to the tracker to check on their progress. However, embedded into a course with a longer duration, we hope that it would be possible to provide more opportunities and reminders to establish the use of the tracker by students to monitor their own progress.

2.3. Integration for Feedback & Discussion

During role-play or discussion activities in a VW, users are generally focused very narrowly on the activity within the VW itself. At such times, web-based resources may appear to be little more than a distraction. But even here there is a role for the VLE.

The University College London pilot activity was based round a clinical practice role-play in SL, Figure 2a. While the VLE was not used during the role-play, students used the SLOODLE Quiz Tool to provide survey feedback at the end of each role-play session, allowing students to record their experiences while they were still immersed in the 3D virtual environment. The clinical tutor was then able to access and view the feedback immediately, and discuss the feedback with the student. In this way, the VLE supported reflection and discussion post-exercise, both while students were still immersed in the VW and after.

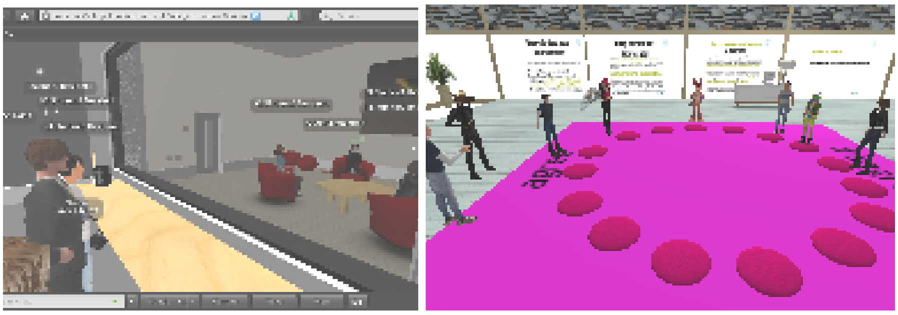

Figure 2. (a) Left - During a role-play activity users focus on the 3D environment, not on web-based resources. **(b)** Right - Discussion groups at The Open University used the VLE for support.

One of the very first SLOODLE tools linked text-chat between a Moodle chat-room and an area of the VW. This has been used to provide logging support for text-chat within the VW, and to aid reflection and asynchronous discussion after the in-world discussion activity has taken place (c.f. [8]). But even without SLOODLE, VLEs can be used to support discussion VW groups. At the Open University, a number of tutors have adopted SL as their venue of choice for group tutorials. This has been particularly apparent on the level one modules *T175: Living in a Networked World*, and *T161: Return to Science, Engineering and Technology*. Both courses are hosted in Moodle and use forums for group discussion, offering tutors a space in which to structure and prepare students for SL activity. Usually accompanied by a reminder email about the date, time and location of the inworld meetup, a typical forum posting might then include reassurance about the skills required for the tutorial, a summary of the planned content, any instructions for preparation and an invitation for questions. The subsequent tutorial would follow the given format and may include discussion, a slide presentation, browser-based activity (such as a search), in-world field trip, collaborative build or bespoke activity such as the debating group shown in Figure 2b. The forum is then used to archive the chatlog and any handouts (notecards). All students, regardless of VW attendance, can then review the tutorial and continue to ask questions and check understanding, providing a fully integrated experience.

3. Accessing the VLE from within a VW

It is possible to access a VLE directly from web-browsers built into current VW platforms. This might not always work as expected, however. When several users view a web page presented on a surface in the 3D space, typically the URL is shared by each client - but not login credentials. This has potential to cause confusion should multiple users try to browse together from inside a VW. Users may also be served different content when accessing web-pages that do not require logging in, as servers may provide different content based on user IP address.

Despite these issues, there remains strong potential for the use of web-content provided directly inside a 3D environment, and there are a range of ways in which such content can be provided. Figure 3a shows a web-page being viewed inside SL, presented in two ways. First, the page is shown on a surface placed in the 3D environment. Second, a user-interface HUD object is worn by the avatar as if part of the UI. In the first case, the page is effectively public – any user who visits that location should see the same content, subject to the provisos noted above. In the second case, the content is private to user wearing the HUD object. A third option is also available in some VW. Interactive web-pages can be added to objects worn by an avatar, held in their hands, or attached to some other part of the avatar, Figure 3b.

Figure 3. Several VW allow web-pages to be added to surfaces in a 3D environment. (a) Second Life/OpenSim allow pages to be shown on a UI HUD object. (b) Interactive web-pages can even be 'worn'.

4. Acknowledgements

This work was partly funded and supported by JISC LTIG VW/VLE grant. Special thanks to Peter Bloomfield for his work on the VW/VLE. Thanks also to Edmund Edgar and Paul Preibisch for continued support for SLOODLE. More information is available from the project home at http://virtualworldsandvles.jiscinvolve.org/wp/

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The UC3M Campus in Second Life: Experiences and Opportunities

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Abstract. The UC3M library has been in Second Life since January, 2008. Since that time, it has created spaces which have not been used as much as we would like but which are very useful for virtual learning, and educational activities and information technology activities have taken place. Their usefulness could be improved if tools such as Sloodle were used, which would connect Aula Global (Moodle) platform with the campus and it could be applied to the blended learning degree programs.

Keywords. Second Life, virtual learning

Introduction

Since January, 2008, Universidad Carlos III has had a campus in the multiuser virtual environment Second Life, whose elaboration and maintenance is the responsibility of the University Library. The campus itself and various activities that have taken place have been described in papers which have been published in specialized journals as well as in other forums and workshops, which can be referred to for a more in-depth description. [1] [2]. At present this campus continues to function; we shall give a brief description of some of the new features and will also talk about its possibilities.

1. Current Configuration of the Campus

The main innovation is that since the new viewer of Second Life was established, objects have been able to be used as Web navigators ("Web on prim"), so that the profiles that the University as well as the Library have in social networks (Facebook, Tuenti, Twitter) are now accessible so as to link these two types of communications tools, as seen in Figure 1.

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Figure 1: Facebook, Twitter, and Tuenti profiles on "navigable" prims

Another innovation is the creation of a specific building for use together with the University teaching platform, Aula Global, which is constructed on/in Moodle. This is of great interest because it gives us the option of being able to use the Sloodle extension, which allows us to combine the possibilities of this open code teaching platform with the 3D immersive environment of Second Life.

Figure 2: Aula Global building in the UC3M campus in Second Life

Sloodle, which has been in development since 2006, receives funding from the British organization Eduserv with support from the School of Library & Information Science at the San Jose State University (California), is an open code project that supplies tools for use in the Second Life environment in teaching and learning [3] [4].

2. Current Situation

It is a known fact that after the important surge of Second Life during 2007 and 2008, it is now languishing to some extent, almost abandoned by many, however with quite a bit of activity in the area of virtual learning, an activity that perhaps does not create a lot of headlines, but it never stops. And that is despite Linden Labs, the company which owns and maintains Second Life, eliminated the discount of 50% that applied to educational entities at the beginning of 2011.

As examples we could cite the Sheffield University, with its Infolit iSchool, devoted to information literacy, the American Library Association (ALA) Island, whose activity has never stopped, or the SJSU School of Library & Information Science itself, mentioned earlier as one of the supporting pillars for Sloodle.

The UC3M Library campus activity has been reduced, given the technical drawbacks involved in using an environment which is quite demanding in terms of computer hardware. In addition, it can be complicated to become accustomed to the environment and that discourages some users. The Library has never stopped incorporating information into the Second Life campus, first, with selected links to the most relevant informative pages and now with the link to the profiles the library has in different social networks, where the goal is to give the most information and offer the most interaction with users

Despite these complications, we have received more than 4,000 visits in the last three and a half years. The following table shows the average number of weekly campus visits, according to the data provided by the sensor installed there.

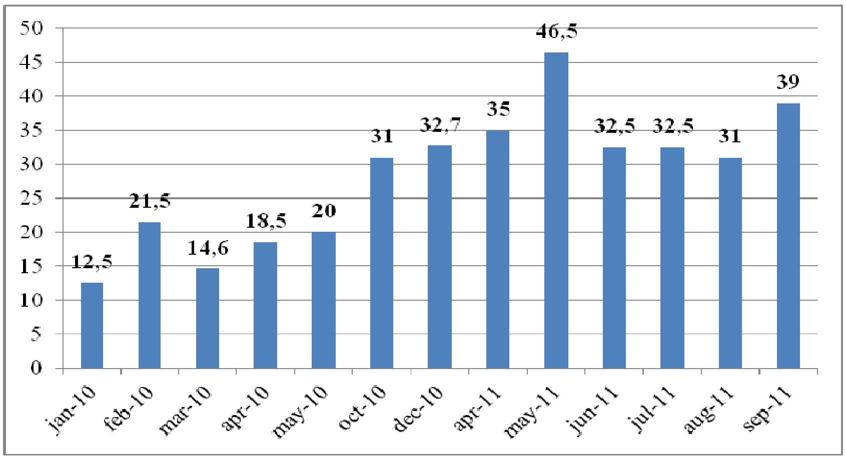

Figure 3: Average weekly visitors of the UC3M campus in Second Life between January 2010 and September 2011 (The sensor has not provided data of all months)

Figure 4: The visitors counter on 29 September 2011

As activities carried out in our campus in Second Life, we can include virtual meetings for library personnel, training courses for blended learning degrees and events such as exhibits and reader's club meetings in the Library.

Figure 5: The Library profiles in Twitter and Facebook in front of the main building

As a curiosity we can mention that despite not having a lot of activities, our campus is still seen as a reference in Spain in terms of university presence in Second Life.

3. Opportunities

In spite of all the problems involved, there has always been interest on the part of some professors in using Second Life for teaching. In fact, due to the requests of some professors, the campus is accessible from the University computer rooms.

If in the future the use of Sloodle will allow us to combine the possibilities of Aula Global with those provided by the virtual environment of Second Life, it is likely that the campus could be used often, especially in regards to the blended learning degrees, where many times, there is a feeling of isolation, which can even lead to a student dropping out. This environment could help to mitigate this sensation so that the student could feel that he/she is in fact together with classmates in a classroom [5].

4. Conclusions

We would like to say that there were lots of activities on our campus, but it is not true. Why? Is there enough information for potential users (professors, students)? Are there too many technical difficulties? Aren't we able to explain the benefit of this environment for educational purposes, especially for blended learning? Or has Second Life as a whole, and specially as an educational environment, perhaps been a victim of its own success? In addition, the elimination of the 50% discount for non-profit educational organizations in 2011 has not helped. In any case, we still think that is a tool we can take advantage of, especially in blended learning degrees as a friendly and immersive environment that can mitigate the isolation that these students often feel and can reduce dropout rates in such degrees.

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How can MMOL platforms improve teacher skills in cultural diversity, values education and attention to diversity

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Abstract. Today's education is characterized by the need to adapt teaching – learning processes to the new social, demographic and cultural reality arisen from changes society has undergone in recent decades. This need encompasses several aspects, of which this paper focuses on teacher training. We put forward the incorporation of 3D learning environments or MMOL (Massively Multiuser Online Learning) platforms to favor the creation of 3D scenarios where the teachers can improve their teaching-pedagogical skills for situations of cultural and ethical concerns that require a high level of contextualization. We have organized the study and improvement of those skills related to three characteristic situations: cultural diversity, values education and attention to diversity. This paper is centered on teachers and students of secondary education enrolled at the Castilla La Mancha (Spain) Institutes. The ultimate aim is to demonstrate whether the MMOL platforms can improve such skills training teachers in virtual and/or augmented reality simulators.

Keywords: 3D learning, educational simulators, MMOL platforms, augmented learning, e-learning, training of trainers, cultural diversity, values education and attention to diversity.

Introduction

In the context of secondary education, adaptation to cultural diversity, values education and attention to diversity are some of the major concerns of teachers, tutors, counselors, parents and educational institutions. Respect for high ability, difference, keeping order in classrooms, non-discrimination, solidarity, harmony, special educational needs, etc. are activities in which much effort is put without achieving, in many cases, the expected results. The search for effective solutions by both teachers and institutions is complex because of lack of time for preparation. In order to find solutions to these problems and help teachers, educational resources specially targeted for teachers and students constitute an important asset. Educational virtual worlds can be hypothesized to become an adequate context for these kinds of educational concerns. Concretely, education regarding values, conflict and diversity require a consideration of a number of issues with a special concern for attitudinal elements. As Steinkuehler et al. [18] suggest usually involving the following:

a) Discrimination of problems and cases.

b) Simulation of scenarios in which these situations show.
c) Establishment of channels that allow the control of its management, and the creation of agreements for conflict solving in tune with the culture and the characteristics of each institution.
d) Improving abilities and skills of teachers by means of training in the virtual world.
e) Identifying those factors that originate the appearance of conflictive and troublesome situations.

In this sense Saunders [1] emphasizes that virtual world based applications provide substantial improvements in aspects such as the communication skills of participants, methods of problem-based learning or exploratory learning experiences. In addition, if we take into account the new educational guidance derived from the Bologna process as embodied in the European Higher Education Area, which introduces significant changes in content and guidance in the teaching process, we find among its training objectives the development of skills and competencies that require innovation in pedagogical methodologies. Research of new pedagogical tools, mainly based on the use of Information and Communication Technology (ICT), lead to tools that can be used virtually and contribute with the approach of skills and competencies development. It is in this sense where the incorporation of online tools, or specific software, like MMOL platforms, where it is possible to generate virtual or augmented reality simulators, is attracting particular interest. However, the use of these platforms requires training for teachers as they need to become participants in the immersive learning experiences.

Therefore, the educational situation to which this research focuses on improving the teaching-learning processes leading to the life-long learning of teachers from educational stages prior to university, namely: secondary education and high school. The research will implement in technology-mediated contexts by using 3D training platforms or MMOL platforms in order to develop on-line virtual worlds or 3D training simulators for teachers on which to perform experiences that can be analyzed appropriately. Training activities will be performed through role-playing dynamics in which it is possible to recreate situations or simulations particularly typical of the current educational reality.

The rest of this paper is structured as follows. Section 1 provides background information on the potential use of MMOL platforms for the kind of contexts considered. Section 2 describes the resources used for the experience reported. Then, section 3 describes the pedagogical approach devised. Section 4 explains an experience in virtual worlds of a typical school situation. Finally, Section 5 provides concluding remarks and prospects for the next steps in the experience devised.

1. Background

Simulators based on three-dimensional environments of virtual or augmented reality have been widely used in various areas of knowledge and professional activities and have allowed a clear improvement of abilities and skills of those who participate in this kind of experiences. Training of pilots, members of the armed forces, doctor in different specialties, etc. by using virtual worlds and simulators is understood to be necessary for both their initial training and their improvement in professional practice.

The simulators are a process for the training of concepts and knowledge construction in general, and also for the implementation of these new contexts to which, for various reasons, a person cannot access from the methodological context in which his learning is developed. In fact, great part of the cutting-edge science is increasingly based on the paradigm of simulation, rather than the experiment itself. The generic features that these tools can provide to education can be summarized in the following points:

- The teacher is an active entity, becoming the constructor of its learning process from its own experience.
- Allow the revision of experiences by specialists and experts that directly or indirectly could contribute to an improvement process.
- Enable the definition and implementation of educational patterns to guide teachers in both experiences and practice teaching.
- Support experimental and conjectural learning.
- Provide an open learning environment based on real models.
- High level of interactivity.
- Allow the learning exercise.
- Help to teach certain skills and competencies.
- The teacher tries to understand the characteristics of the phenomena, how to control them or what to do under different circumstances.
- Promote exciting or entertaining situations that encourage informal learning.
- Store results and experiences in order to be able to analyze and review guidelines for action.

Many authors have developed theoretical formulations on the use of simulators and virtual reality environments about improving the skills and abilities:

- The work and research on simulators in Social Sciences of Robert Axelrod [2].
- Comparative studies of Issenberg, Pugh, Wayne, McGaghie, Petrusa, Lee Gordon, Scalese, etc. [3], [4] about using virtual worlds and simulators in medicine.
- Proposals for Clark Aldrich [5] in his book "Learning by Doing: A Comprehensive Guide to Simulations, Computer Games, and Pedagogy in e-Learning and Other Educational Experiences", on how to choose appropriate simulators for the right situation.
- It is also interesting to consider the initiatives undertaken in some countries especially relevant in the educational field, as is the case in Finland. The project is called "Future School of Finland" (http://edu.ouka.fi/~koulunet/futus/), which will let institutions, schools, teachers and students take part in the change to the school of the XXI Century. The educational framework is based on research projects about methods of event-based learning, creativity and all from a transverse dimension of educational technology and education itself.

2. Resources

For the implementation of the simulator has been used a MMOL platform specifically created for this purpose. The generic representation of this architecture is shown in Figure 1.

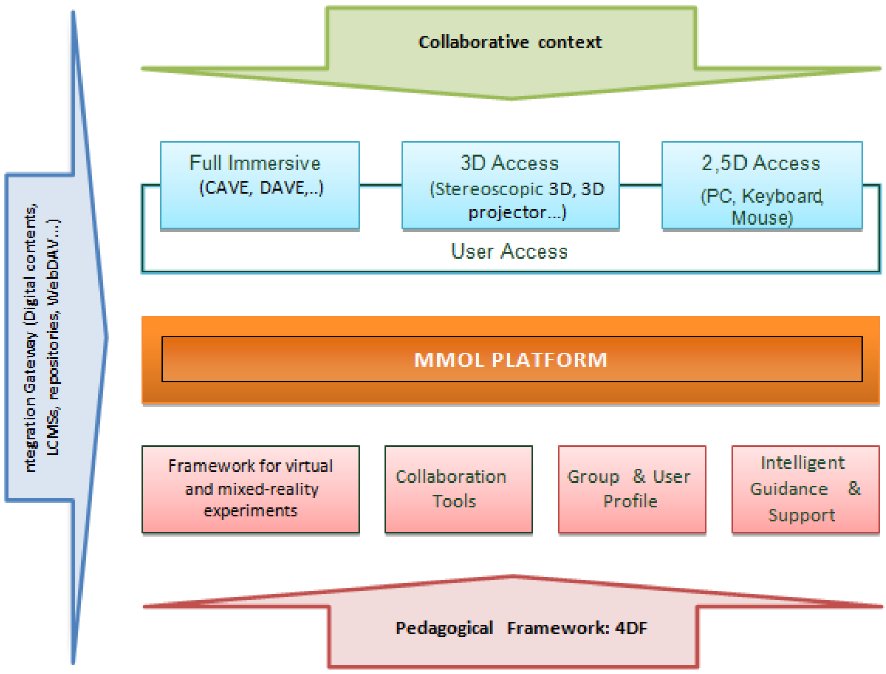

Figure 1. MMOL platform architecture

MMOL platforms are characterized not only by the capacity of immersion in the educational context and its corresponding social interaction, but also by the idea of being able to interact with the proper context without time restrictions. Much of these solutions are based on 3D models with integrated real-time audio and various collaborative tools, but human interaction "within the world" is largely limited to a 2D screen, keyboard and mouse. This user interface is known as 2.5D. It is believed that such solutions are not fully immersive, but they approach the 3D technology which is becoming more common in the consumer market, such as 3D video-game consoles, 3D televisions, 3D projectors, etc. However, the experience requires a fully immersive interface based on improved devices and supplements which are not so common in the field of mainstream users, as is the case of CAVE (Cave Automatic Virtual Environment) or haptic devices.

The foundation of MMOL platforms are the servers of virtual worlds. In our case we opted for one of the solutions that offers a more evolved environment and allows a clear adaptation to experimentation and simulators. It is the realXtend (http://www.realxtend.org) project originally based on OpenSim but adds some improvements such as: support for editing and publishing "3D meshes", scripting in

JavaScript and/or Python. It provides solutions for both server and client integrated in a single program (*Tundra 2.0*). The server functionality integrates advanced services like OpenID authentication, WebDAV inventory, render based on the Ogre3D graphic engine, etc. The client functionality provides the stereoscopic representation of scenarios, and also a CAVE environment. But anyway it is necessary to add other components that allow the adoption of a clearly educational approach, such as:

- Collaborative tools for simulation environment generation, such as:
    - Tools for creating sceneries and 3D content.
    - Integration with learning object repositories or RMOLs (Reusable Minimum Object of 3D Learning).
    - Utilities for the creative design of "serious games", as Sara de Freitas [6] indicates.
    - Assistants for generating storyboards of the simulated situations.
    - Toolkits for creating intra-world augmented reality systems.
- Collaborative tools that generate educational experiences appropriate for a simulation environment:
    - On-line synchronous tools for collaboration such as videoconference, voice chat, text chat, etc.
    - Browser to display intra-world content.
    - Logic interfaces to integrate haptic devices.
    - Services to incorporate mirror worlds, like Google Earth does.
- Languages and contexts to create guides and automatized assistants for learning.
- Tools to manage users, courses, groups, teachers, etc.
- Gateway for integration with conventional digital content, such as: learning management systems (Moodle, Blackboard, WebCT, ATutor…), Google Docs, YouTube, etc.

This requires a new approach of the pedagogical foundations that apply to the educational actions conducted in these new environments. As noted in the next section, the educational framework of the 4 Fs [6] is a good reference.

Therefore, we conclude by defining the concept of MMOL platforms as those virtual and/or augmented reality environments built on virtual world servers that provide interactive learning by means of 2D, 2.5D, 3D or fully immersive interfaces, appropriate for creating and managing on-line collaborative learning platforms in which individuals will participate in a real way or a figurative way (avatar).

Figure 2. Interactions in the MMOL platform

3. Pedagogical context

S. de Freitas [6] and [7], based on research carried so far, believes that early adopters of these technologies are usually those who are related to professional qualification of workers where the virtual worlds have a clear potential, due to their use of the most experimental learning models. This same idea can be extended to the case of training of teachers in areas like the ones considered in this study: attention to diversity, multiculturalism and values education. The fact that these learning areas, or other yet to be determined, can have these new environments requires an exhaustive review of the pedagogical foundations, and at the same time have patterns and learning models that help to design, develop, select, evaluate and use the virtual spaces from the MMOL environments. An example is the so-called pattern or framework of the four dimensions, [6] and [7], according to which all the training activity typical of MMOLs involves a necessary planning of tasks: from an analysis based on identifying the training needs, until a final evaluation of the results (Figure 3). Each stage of this planning must have as last referent the definition of a set of specific and accurate learning objectives, tailored to the recipients of such training activity (the learner-centered teaching). Therefore, the four dimensions of the pattern applied to the analyzed experience are as shown in figure 3.

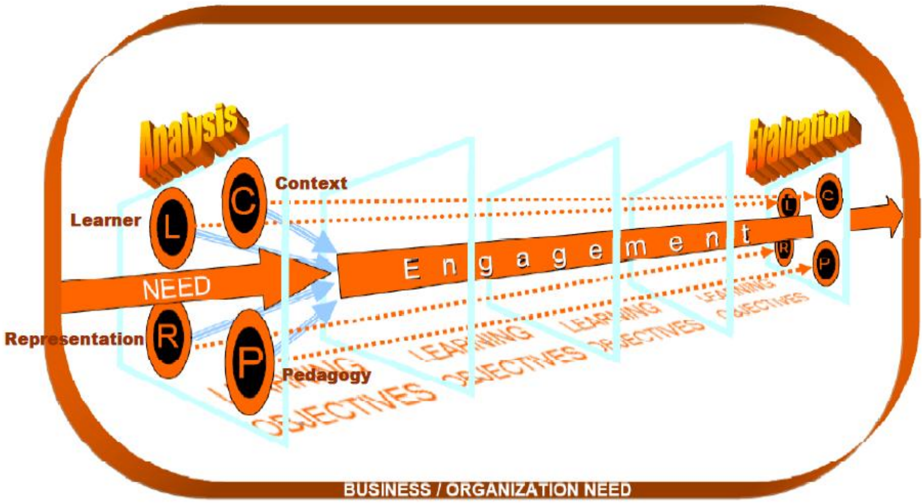

Figure 3. Planning of the 4 dimensions framework.

Taken from S. de Freitas. (http://www.knowledgelab.dk/now/pel/filer/sara_de_freitas_ppt.pdf)

1) Learner dimension, which includes the definition of profiles, roles and competences. In our case, these are teachers that, through role-playing activities, simulate typical situations in some of the three target areas of study. One of the teachers plays the role of mediator or guardian to undertake appropriate actions to enable the resolution of potential conflicts. These operations are supervised by experts in such areas to identify good practices, or to suggest improvement actions.
2) Context dimension: description of the learning environment, ways to access to learning, available resources. From real situations from the schools of Comunidad de Castilla-La Mancha, have been built and designed the spaces that reproduce in the platform the environments where such situations have been contextualized: playground, sport fields, classrooms, locker rooms, etc.
3) Representation dimension: immersion degree provided by the platform when conducting the learning activities, fidelity and accuracy of what is represented, and interactivity. Each teacher participating in the experience plays a role among those recognized from the real situation to analyze. They incorporate gestures, vocabulary, expressions, pseudonyms and references observed in students who took part in these situations.
4) Pedagogical dimension: It is adopted an approach based on problem solving [8]. In addition, it is promoted a way of learning by exploration through role-playing activities, such as situated or contextualized learning [9], and especially “connected” learning [14] [15] based on connectivism of G. Siemens [16].

4. Experience

Given the Framework 4D, have been characterized various typical situations that will serve for the design and construction of the MMOL platform simulators. In order to make easier the collaborative work, has been used the technique known as "Research Groups" of Sharan & Sharan [16]. By way of example, table 1 shows a description of one of the situations under study.

1. Experience Title	*Attempt to appropriate the school basketball court in recess by an organized and violent group of South American students.*
Date	11-May-2011
Responsible (Name and e-mail)	...
General description of one specific situation characteristic of multiculturalism *(10-15 lines)*	A group of four Spanish students is playing at the recess on the school basketball court. Then a group of ten South American people arrives and they begin to push them violently to dislodge the basketball court, and they take them off the ball. One of the Spanish students tells them that the basketball court is for everyone. The South American group leader responds that they have to leave or they will regret and not to even think of going there again nor talking about that with any teacher. This situation has been the case since the beginning of the course. The students who were playing, in view of the aggressiveness and the higher number of students, decide to leave and go talk to the director of studies.
Describe the scenery/place (classroom, corridors, playground, street, …) where the situation is located.	Basketball court.
List which objects, resources, tools… are present in the scene. Justify the reason for their presence.	Personal resources: A group of 10 South American students, a group of 4 Spanish students. Environmental resources: school basketball court. Material resources: ball. At recess, students can play on the basketball court. The South American group takes them off the ball.
List those involved identifying the role of each of them. Justify the reason for his intervention.	In the South American group there is a leader and the rest are those who follow and obey him. Group of four Spanish students that were forced to leave the basketball court due to the violent attitude of the South American group.
Identify the characteristics of this situation which are characteristic of multiculturalism.	Intolerance, conflict, marginalization and disrespect for rules. Sense of impunity by the group of South American students. Feeling of helplessness, because of being a minority, by the Spanish students.
Describe one typical action in the described situation which is characteristic of multiculturalism.	Group of South American students trying to impose its rules and feel superior to others.
Describe another typical action identified in the situation described which is characteristic of multiculturalism.	Resort to violence to impose their rules. Assuming that the organized group is free to impose their wishes and always show others the “power” they enjoy within the school.
Describe one intervention characteristic of multiculturalism to promote the described situation.	In tutorships should be remembered the rules of the school when using the common areas. Teachers that monitor at the recess will control that the basketball courts are used adequately and correctly.
Describe another intervention characteristic of multiculturalism to promote the described situation.	With the help of all teachers who teach the South American group, tutor, counselor, department of coexistence and their parents, it will be tried to use behavior modification techniques and lectures to attempt that students respect other fellow.

	Given the seriousness of the facts and the potential danger that may result in a situation more difficult to solve, it would be advisable to seek assistance from other social agents.
General comments on the situation described.	Collaboration of families is very important to achieve behavior modification. However, often one of the problems and critical factors in the behavior of these groups of students is the lack of attention, support and interest from their families. Therefore, it is essential that all the school agents and other members of the educational community work as a team.

Table 1. Cultural diversity experience.

From the situation described in Table 1, a 3D space is reproduced on the MMOL platform. Those who participate in the experience adopt the different roles assigned previously to simulate the described situation. There are experts that assist teachers on how to intervene to resolve the conflict.

5. Prospects and conclusions

Immersive technologies are creating important challenges such as: the need of open standards for integrating platforms, contents and avatars, the validation of resources and the evaluation of the applied techniques. In terms of educational resources, two difficulties appear:

1. Having *"friendly"* and not complex tools that allow developing 3D micro-objects for learning: the so-called MOL (Minimum Object of 3D Learning).
2. The need of develop new standards which allow the definition, classification, valuation, packaging and reusing (RMOL, Reusable MOL) of these new objects. The traditional standards need to increase their semantic capacity in order to be adapted to the 3D world.

Something similar can be stated regarding to the educational techniques: instructional design, content sequencing and learning pattern need to be adapted or reformulated in terms of collaborative virtual environments. Are needed, then, new standards and tools that make easier the production of learning activities that take place completely in immersive environments. And regarding to the evaluation of MMOL platforms, RMOLs or 3D courses there is also a lack of references, rules or standards.

All these challenges require the adoption of novel approaches, innovative and creative, both from the psycho-pedagogical disciplines and the purely technical-computing, so that all the participants of the educational context are taken into account: teachers, learners, institutions, educational systems… physically or virtually represented.

Regarding to the experience carried out, the development of this first phase of the project has served to confirm the potential of the MMOL platforms to train teachers. It has been shown how once a topic is selected and through the application of an specific strategy like the one proposed by Sharon and Sharon [16] and an adaptation of the context following the 4D framework, a very effective way of working can be structured. The participation of the groups has been very high and productive, and the content and 3D sceneries created can be reused in other trainings and experiences.

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Learning Enhancement in Higher Education. Validation of an Educational App Based on Augmented Reality Technology

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Abstract. In this paper we introduce validation of a physical interface (augmented book) based on augmented reality technology for learning of standard mechanical elements. This book was included in the curriculum of engineering graphics subject in the Mechanical Engineering Degree in a Spanish University. Twenty-five students used it for studying representation and designation of standard mechanical elements. A control group composed by twenty-two students used traditional class notes with static images for studying the same contents. We have analyzed results through an evaluation test and a satisfaction survey. Results show that experimental group students enjoyed studying through the use of AR technology and even obtained better results in a contents evaluation test.

Keywords. Augmented reality, Mechanical Elements, International Standards, Engineering Graphic.

1. Introduction

Learning with technology involves learning situations in which the instructional experience is created with the aid of a physical device, such as a computer or the Internet. At some level almost all learning involves technology. For example, in a traditional lecture, an instructor may use chalk and a chalkboard, thereby employing an old but reliable technology. Similarly, a textbook constitutes a form of technology albeit one with a 500-year old history [1].

Over last decade leisure and entertainment world have developed very attractive devices for younger population reaching the point of becoming essential. It's fact that when most students reach college they are used to new technologies and computer use.

Teachers notice that new generation of students in graphic engineering subjects show far more interest and pay more attention when they use CAD tools, multimedia material, web resources, virtual platform and social networks showing apathy and less motivation when using traditional drawing tools.

This paper focuses mainly on learning with augmented reality technology. An important feature of computer-based technology, and possible advantage if used appropriately, is that it allows presentation of multimedia instructional messages [2] that is, instructional messages consisting of words (spoken or printed) and pictures (such as animation, video or 3D illustrations). Computer-based technology also allows levels of interactivity and graphic rendering [1].

One of main advantages while using this technology is student's adhesion which allows establishing contact with studying tasks. Learning processes use to be long implying many times boring didactic materials causing that those subjects are being dropped by students.

AR technology allows interaction, motivation and it can be used even at home. It's true that adhesion to any technology disappears overtime if used frequently. This kind of technology will focus on a specific content of the subject preventing that studying it becomes a routine when students are no longer interested in it.

In this paper benefits on teaching and learning are analyzed as well as use of didactic material with additional information supplied by augmented reality against use of traditional class notes. Both AR based didactic material and traditional notes seek that students learn sketching, designation and normalization of mechanical elements following ISO standardization international rules, ASME-ANSI, DIN regional regulations and UNE Spanish standardization rules [3-13]. These contents are common in subjects such as Graphical Engineering, Machines design and Mechanic technology among others. Students should master these fundamental subjects for a successful professional performance.

2. Augmented Reality environments

Virtual reality (VR) is use of computer graphics system combined with various displays and interface devices for providing the effect of immersion in the interactive 3D computer-generated environment. From VR technology onwards arise augmented reality (AR) which technology merges virtual images with real ones keeping contact with the real world while interacting with virtual objects.

Azuma [14] defines AR as a system containing three characteristics at the same time: merge of real and virtual, real time interactivity and 3D registration. Milgram continuum [15] and Azuma [16] are the most commonly accepted definitions of augmented reality. Azuma defines AR as variation of virtual environments also known as virtual reality. VR technology completely immerses user in a synthetic environment which can be interacted with obtaining answers while not seeing the outer real world. Otherwise, a virtual reality environment allows user seeing real world with virtual computer-generated objects superimposed or merged with real surroundings. Finally, augmented reality doesn't replace real world so user's visual perception over real and virtual objects is the same.

Basic scheme of an augmented reality system consists in a camera which captures snapshots of the real world connecting to a computer that makes necessary calculations for merging virtual objects into the real scene. The result is an image shown to the user through a graphic interface (Fig 1).

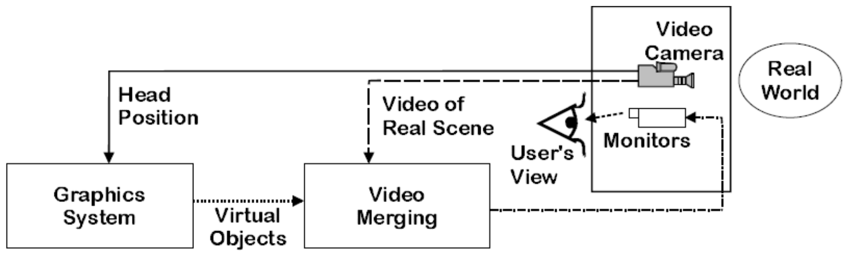


Figure 1. Basic scheme of an augmented reality system [26]

Aim of AR is creating an environment where real life is enhanced by virtual elements in real time. The purpose of AR is enhancing the information we naturally receive through our five senses, by addition of superimposed, constructed virtual elements for bringing additional information which may not be possibly seen by natural means. One of its most important characteristics is the way in which it creates an interactive environment between computer system and user. Today's AR environments create interactive systems that aren't simply a face-to-screen exchange any longer, but an interaction with the whole environment as well. (Fig.2)

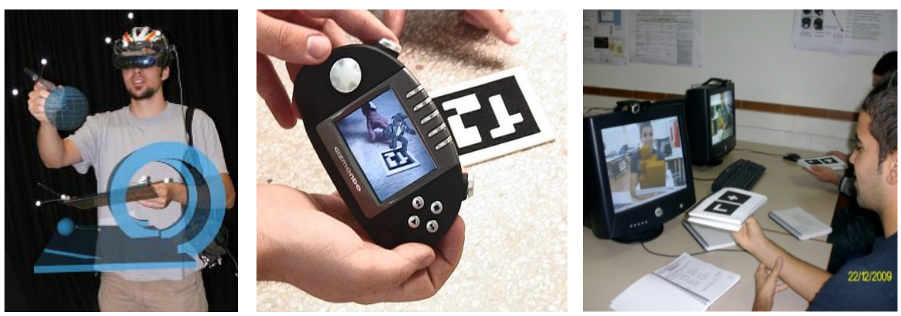


Figure 2. Augmented Reality environments.

Short characteristics of an AR environment:

- Combines real and virtual environments
- Is real-time interactive
- Is registered in four dimensions (three dimensional space and time)
- Virtual objects can be stationary or manipulated
- There is interactivity between the object and the real world
- Abstract concepts can be made visible, enhancing understanding

3. Augmented Reality in Higher Education

According to The New Media Consortium's 2011 Horizon Report [17] augmented reality becoming a tech trend in higher education is just two to three years away so technology blending virtual and real expected to reach mainstream use in education through augmented reality textbooks (augmented book).

It's nearly impossible forecasting what technology will bring next year but is possible to predict its perspective in ten years. I regard that one of most relevant changes in our society will be augmented reality which is a technology that is actually being developed in several fields[1],[2] and applied on tasks belonging to medicine, architecture, marketing, advertising, military, archeology, leisure, etc.

Versatility offered by AR technology has allowed development of applications on several knowledge areas of education like mathematics, mechanic, physics, town planning among many others. In higher education there are very few applied teaching apps so here are the only ones known to date:

- *Interactive Media System Group*[3], researchers from Institute of Software Technology and Interactive System (Vienna University of Technology), is pioneer on development of augmented reality applications for education. Construct3D app, as described in [18-19], is an application designed for teaching mathematic geometry in higher education. Apps allow creation of geometric scenes so both teacher and student can interact while explaining. It can be used in three different ways:
    - Autonomous mode where student can see and interact with objects built by himself
    - Collaborative mode visible for every user, and
    - Teacher mode allowing him choosing visibility between some students or all of them.

Kauffman, proposes giving an augmented class where students are provided of HMD and can interact with virtual objects and make exercises following teacher's advice. Same authors developed an educational tool for explaining physical experiments [20].

- In engineering education, Martin-Gutierrez has developed a training that improves spatial skills of students [21]. Application is based on performing graphic engineering exercises using augmented reality.
- In medical education, seeking training of future anesthetists, an AR simulation is proposed using operating theater material [22].

In higher education, some AR experiences have been performed already but haven't generated any didactic material for continued use, we can just mention a collaborative learning study in Land and town planning fields [23]. Experience concludes showing that AR technology may improve design of tasks performed by students. Another interesting basic app on AR field is developed by Gillet, Sanner, Stoffler, Goodsell, & Olson [24].

[1] http://www.wikitude.org/en
[2] http://studierstube.icg.tu-graz.ac.at/handheld_ar/
[3] http://www.ims.tuwien.ac.at/

4. Augmented Textbook

We will call augmented textbook SMELAR – ***S**tandard **M**echanical **E**lements **L**earning through **A**ugmented **R**eality.* Augmented book is composed by two volumes containing 8 chapters:

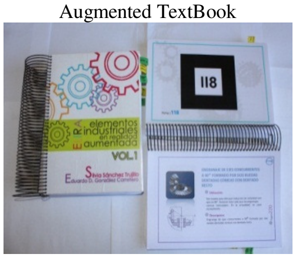
1- Simple thread elements: bolts, nut, stud.
2- Non thread simple elements: Pins, cotter pins, washer.
3- Security device
4- Bearings
5- Gears
6- Spring
7- Motionless Machines
8- Machines in motion

Each chapter has an introduction with theoretical contents and the following technical card of each standard element. Card has literal information about use, rule number and element standard designation. Besides it contains graphic information about standard representation, photorealistic image and a marker which allows visualization of the 3D standard element from any point of view through augmented reality using BuildAR[4].

Fig. 3. Technical card sample

In the following images we may see a student manipulating SMELAR cards.

Augmented TextBook



Hex-head screw

Hex-nut perforated

[4] Human Interface Technology Laboratory New Zealand (HIT Lab NZ), http://www.hitlabnz.org/BuildAR

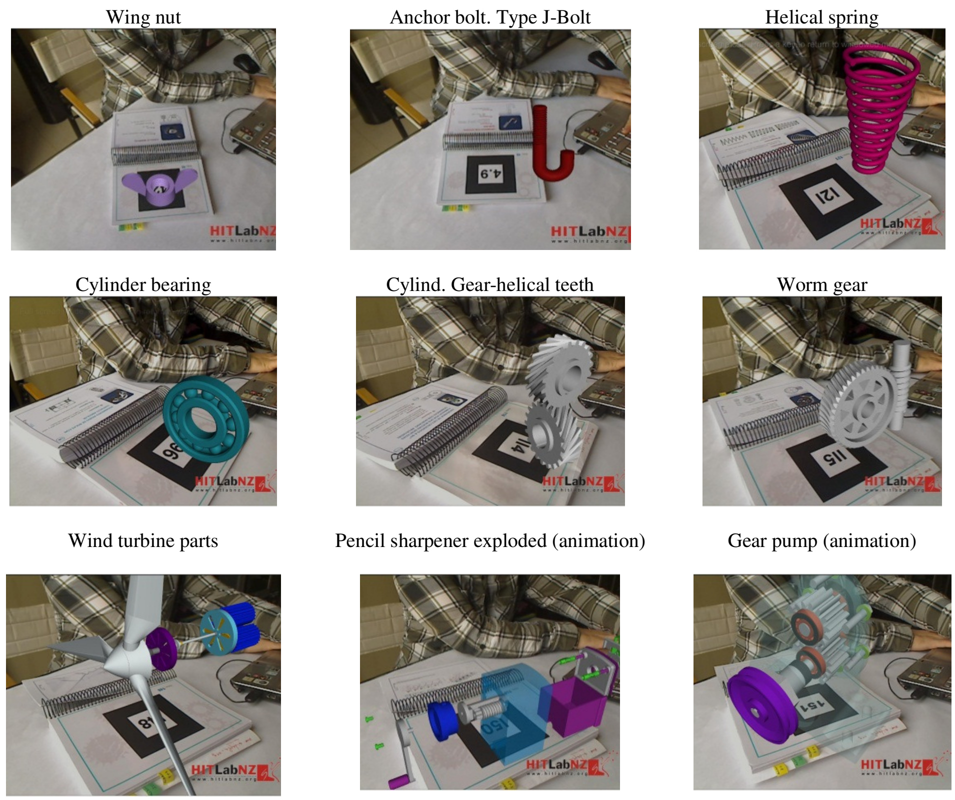


Fig. 4. Augmented information on SMELAR.

5. Empirical Study

A study was performed with first year students from Mechanic Engineering of University of La Laguna (Spain). Graphic Engineering subject contents are structured in several blocks so when each one is finished an exam is proposed. Students taking part in the experimental study has passed all evaluating tests from graphic engineering subject. Last block of the subject seeks knowledge, sketching, designation and normative of standard mechanical elements.

5.1. Participants, Design, and Procedure

A total of 47 students from first-year of mechanical engineering ranging in age 17 to 21 (M=18.7, SD=1.1) took part in the study. Twenty five of them belong to the experimental group because they will use the augmented book for studying and following teacher's explanations. The other students (22) belong to the control group which will use traditional class notes. Experimental procedures took part in the last 6 weeks of the academic course 2009/10 (April-May 2010).

Teacher explains each of the standard mechanical elements like previous years. At the end of experimental procedure students belonging to the study will perform an exam for evaluating their knowledge about mechanical standardization. They know already that with this last effort they will pass the subject completely so they will be responsible while studying it.

Meanwhile, experimental group will complete a survey designed for data collection and AR material effectiveness levels measurement as well as technology efficiency. Besides, student satisfaction will also be measured respecting AR technology use. Bevans points out that effectiveness value measured is the average score of participants' answers (using a numeric scale) and respecting efficiency and satisfaction we may obtain a qualitative or quantity value depending on how questions are formulated [25].

Both, experimental and control group, will perform a survey for evaluating motivation levels when studying this contents. We regard that material used influences on result as it's the only controlled variable which is different on both groups. Questions asked are shown on table 2. Students answer using Likert's scale with a range of values between 1 to 5 (Totally disagree, Disagree, neither agree nor disagree, Agree, Totally agree)

6. Measure and results of effectiveness, efficacy and satisfaction

For checking if material used for studying has influenced over learning we regard scores obtained by students from each group (control and experimental). Table 1 contains average score and standard deviation for each group. It is interesting pointing out that in experimental group 20 students passed from a total of 25 meanwhile in control group only 11 of 22 were successful.

Table 1. Average values and standard error in academic performance

	Mark (Std. Desv.)	**Std. Error**
Experimental Group (L-ELIRA) n = 25	5.84 (1.54)	0.31
Control Group n=22	4.5 (1.84)	0.39

For statistical analysis t-student contrast is used to compare statistical difference between averages value from both groups scores. We consider null hypothesis H_0, in the fact that there is no statistical difference between average values of both groups. Result of comparison between both average values using "*t-student in independent series"* shows that both scores are different from the statistical point of view so null hypothesis H_0 is rejected (t =2.708, p-value=0.009). P-values below 1% indicate that students have a probability over 99% of obtaining better results using the augmented book.

Kolmogorov-Smirnov Test compares the distributions of two samples. This test is performed by computing the maximum distance between the cumulative distributions of the two samples. In this case, the maximum distance is 0,458 (K-S=1.567, p-values=0.014). Since the P-value is less than 0.05, there is a statistically significant difference between the two distributions at the 95% confidence level. We can conclude that academic results are statistically significant when comparing results from experimental group with the control group.

In usability there are different quantitative measures established which allow knowing product's acceptance level; in our case, we will find out didactic material and used technology's success rate. In table 2, values are shown for effectiveness, efficiency, satisfaction and motivation. Augmented textbook has been positively appreciated with effectiveness value of 4.47 points, almost reaching the 5 points top score. Among other valuations, students regard that book is visually attractive, contents are appropriate and are nicely structured. Book size is suitable for correct performance of necessary gestures when visualizing augmented information. Augmented textbook is regarded as quite complete about information supplied as they consider there is no need to check out any other documents while studying. About efficiency and satisfaction all matters are positively valued. Every student (100%) believes technology used us interesting and most of them think it will help them performing a better final exam. Overall appreciation is that AR technology and augmented textbook base in it allows easy learning becoming a frustration-free tool for the user (as shown on figure 5).

Table 2. Effectiveness, Efficiency and Satisfaction survey

A	**Effectiveness material. (error free)**	Mean Value (Std error)
A1	Augmented textbook is nicely presented	4.8 (0.08)
A2	Proper chapter contents structure	4.76 (0.77)
A3	A5 textbook size adequate for virtual contents manipulation.	3.88 (0.1)
A4	No image leaps when manipulating virtual objects	4.72 (0.2)
A5	AR application stability (doesn't freeze)	4.84 (0.1)
A6	No additional content needed while studying	4.84 (0.1)
A7	Allows following teacher's explanations	3.44 (0.3)
	Mean Value Effectiveness	**4.47 (0.2)**

B	**Efficacy y technology satisfaction (speed)**	
B1	Augmented textbook is easy to learn	4.84 (0.04)
B2	I would rather choose traditional class notes over new augmented textbook	1 (0.0)
B3	Proper 3D figures visualization with no definition problems	4.88 (0.1)
B4	I think this augmented textbook will help me performing a better exam	3.72 (0.2)
B5	I liked using this augmented textbook at home by myself	3.88 (0.2)
B6	Augmented Reality technology has been interesting to use with this didactic contents,	5 (0)
B7	Augmented Reality is useful for studying this didactic contents	4.12 (0.3)
B8	How do you value the Augmented Reality technology working with three-dimensional models? (1 bad – 5 excellent)	3.96 (0.5)
B9	Technology Augmented Reality technology seems useful	4.4 (0.2)
B10	Objects' use and manipulation with AR technology is frustrating	1.36 (0.2)
B11	Overall experience rating	4.32 (0.3)
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C	**Motivation**	Exp. G	Ctr.G
C1	Sometimes studying gives me a feeling of deep personal satisfaction.	3.86 (0.03)	1.86 (0.03)
C2	I feel that virtually any topic can be highly interesting once I get into it.	4.64 (0.02)	2.22 (0.04)

C3	I find that studying academic topics could sometimes be as exciting as a good novel or movie.	4.92 (0.01)	1.04 (0.01)
C4	I work hard while studying because material is interesting.	4.96 (0.008)	1.59 (0.04)
C5	I attend most classes with questions in mind that I want to answer.	1.2 (0.02)	1.23 (0.05)
	Mean Value Motivation [StdDev]	**3.94 [1.50]**	**1.76 [0.97]**

For motivation measurement five questions have been formulated. Average score obtained by the experimental group is higher than control group. We compare is there is any statistically significant difference between both groups over the weeks in which study took place. Applying t-student on each question we may obtain p-values equal to zero. Regarding average value of 5 questions as overall motivation score we find that p-value is null as well. We may conclude that there is over a 99% chance that students feel higher motivation using augmented textbook compared to traditional class notes.

Table 3. Statistical result. P-value on motivation questions.

Question	P-Value
C1	P-value=0.000
C2	P-value=0.000
C3	P-value=0.000
C4	P-value=0.000
C5	P-value=0.001
ALL	P-value=0.000

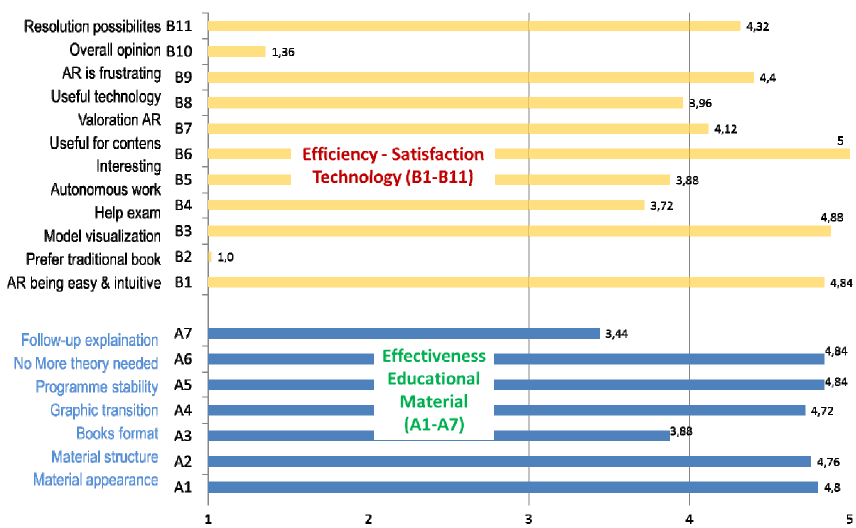

Figure 5. Effectiveness, efficiency and satisfaction results.

7. Conclusion

Results obtained show benefits from augmented textbook use. Students may get better results than using just traditional textbooks. They also show higher motivation while performing tasks and studying. Besides satisfaction level over augmented textbook use is quite high. Textbook's information increment allows less need of consulting any other documents for obtaining information.

Following the same trend pointed by The New Media Consortium's 2010 in Horizon Report, I regard augmented technology will be used in university didactic material in the short-term where students use electronic gadgets (smartphone, iPads, laptops, etc.) frequently while studying and looking for information.

Acknowledgements

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Learn by playing with your information in a virtual 3D learning environment

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Abstract. This paper discusses the learning culture changing and how virtual 3D learning environments could meet these new challenges. The paper presents a TOY virtual 3D environment as a case example based on technical development from education point of view, but also from experiences from real users in authentic learning environment. The paper discusses also the meaning of avatar and especially from a non-verbal communication point of view and concludes need for future studies in order to enrich learning experiences.

Keywords. 21st century learning, 3D, virtual learning environment, open source

Introduction

Virtual schools are here to stay. There is a large variation of different kinds of virtual learning environments [1][2][3]. However, traditional Internet based two dimensional (2D) environments are not enough to meet future challenges in terms of open, mobile and immersive learning. More recently developed virtual learning environments have turned the approach towards three dimensional (3D) learning spaces. [2][4][5][6] Learning can be more motivating and interaction with the 3D environments or objects can enhance a learning experience when compared to the real life learning situation. [7][8][9] 3D virtual worlds have been studied for a number of years as an e-learning environment, primarily by higher education facilities [6][10][11]. However, there are still lacks in usability and user experience issues. Therefore, more studies need to be carried out in order to improve the user interaction with 3D spaces and objects.

The TOY project is a Future Learning Environment that makes heavy use of an extensible virtual world based on the realXtend [12] platform. The realXtend engine was chosen as it allows easy content creation, modification to the world and content ownership. The TOY project is part of the 'Future School of Finland' program [13] which aims to develop a comprehensive learning environment to meet future challenges. This means new approaches for all aspects: teaching, leading, updating training, technology solutions and physical learning environments. The TOY environment allows teachers and students to create, edit and work together on school learning programs. This paper discusses the changes in learning and social cultures, but also in electronic operational culture and tools. In addition, the paper introduces experiments conducted with real users in authentic learning environments and propose topics for future studies for improving learning experience.

1. From traditional schools towards 3D virtual learning environments

Learning is at the core of the society and its renewal. It's not just the competitiveness of individuals and groups, but the competency of the good life. Learning is living and experiencing. Work culture has undergone a rapid transformation. Traditional paperwork has been replaced by information technology and almost paper-free offices. Most adults work with computers on a daily basis. Without them, many tasks could not be performed at all. We all carry a laptop and a mobile phone “or two” at all times. This transition did not happen overnight. It took time and met resistance, but in the end, change was inevitable. Society and its members have a tendency to develop themselves and the operational culture around them.

Education, school and learning environments are the last frontier where the new way of thinking and acting has not struck root. School in its present form is too far from the surrounding society. The pedagogy required for the change in learning environments has existed for a long time, but its message has not reached the field. Old-fashioned methods in old-fashioned spaces, such as teacher-led, textbook- and subject-bound teaching confined to the classroom, are still very much in use. The use of information and communications technology has been regarded as something “out there”, with preference given to tried and tested instruments.

The discussion about the development of e-learning environments first revolved around the Internet, notably websites and how to create them in schools. E-mail was gradually accepted as a means of personal communication. Then followed e-learning environments and systems developed and built by each party for its own use. Since the systems could not be shared, they remained by and large electronic data archives and storage places. They were not cut out for image transfer, communication or actual work. Gradually e-learning made way for mobile learning and finally to the use of social media in teaching. New solutions have created a situation where the learner is mobile and works with personal, significant information in a world that is full of content and media. 3D virtual environments are part of next generation technology (Figure 1) combining the best of previous solutions. They provide the most versatile and natural environment for e-learning. Moving and operating in a 3D virtual environment comes naturally to us; after all, our real world is also three dimensional.

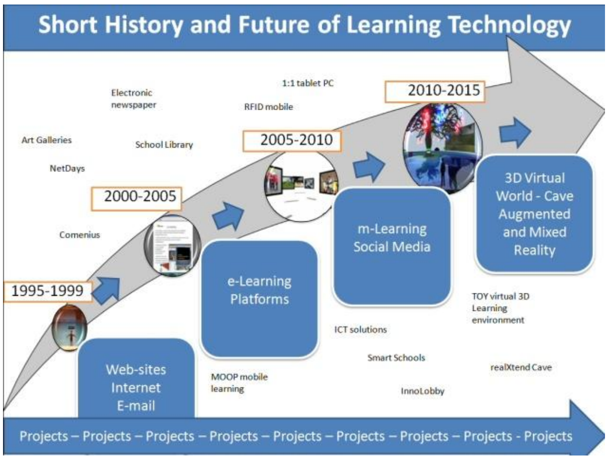

Figure 1. A short history of learning technology.

1.1. Open source realXtend technology

The strength of the open-source virtual worlds lies in the common standard and resulting mobility between the different worlds. Worlds built with the same tools will be linked, and their services and content available to all users. In the future, different countries, ministries or organizations, those supporting a common cause or sharing a common interest or a hobby, can support their operations with a virtual environment that links them to future 3D Internet content.

RealXtend is a non-profit open source project started in 2007, the goal of which is to advance the Immersive Web by creating and participating in the creation of technologies that enable rich interaction in virtual environments. The results of the project are licensed so that everyone can use and develop them further without cost. The licensing is designed to maximize the usefulness and development potential of the system, specifically ensuring that it becomes a viable platform for business applications.

Virtual reality environments have been used in scientific research and other special applications for years. Recent advances in technology have enabled consumer level computers to run immersive virtual worlds, which has led to an increase in the number of users and business application potential. In practice, virtual worlds and the services they offer will reach their full potential only when they become a global network, which will enable users to travel between different services without having to switch to a different browser for every application.

The number of interesting applications for the near future is great, and a truly functional virtual reality platform has to cope with a number of different use cases, from city planning to elderly care or teleconferencing software. Virtual reality's strongest points are interpersonal communications applications and human-technology and human-information interfaces. This serves as a good platform for learning or a meeting environment as TOY is. RealXtend is built on international co-operation, the main developers in the project so far being companies from City of Oulu, Finland.

The Figure 2 presents an ecosystem of virtual worlds and how they have developed during the last two decades.

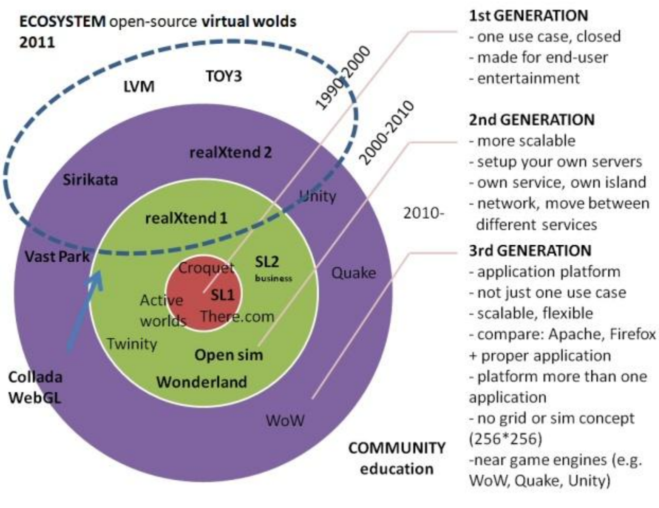

Figure 2. An ecosystem of virtual worlds.

1.2. Need for 3D learning environment

Virtual worlds are under vigorous development, and the potential seen so far is just the beginning. The future learning environment has been designed for the inquisitive examination of phenomena and the processing of information in a game-like format. Imagine yourself as a teacher, standing in the middle of a classroom, wishing that by simply clicking your fingers the learning environment would transform into something different, something that could demonstrate the topic under discussion. In a virtual environment, this is already possible. By recording and downloading, the learning situation can be changed very quickly, say, from a rainforest to a desert. The virtual learning environment supports formal teaching whilst simultaneously enabling informal ways of learning. In a traditional learning environment, students meet friends who live within cycling distance from the school. In a virtual environment, students can still meet the same friends during or after school but also learn alongside their peers regardless of place. Local learning still works, but it can easily be changed into global learning, much like the modern world.

Presently the existing virtual worlds are originally created for adults, but in the future certain parts of it will also be made accessible to younger users. What features do people look for in a virtual world? A learning environment such as this should provide tools for drawing and writing together, have another level or space for learning, allow natural voice communication, provide an option to build personal identities, and the capacity to record and download all handled data. The TOY environment has all these features. The next development phase will focus on improving the usability of the environment and introducing special features to enhance learning and data handling. The environment can also include services for groups with special needs. In the end, the users are the ones who define what kind of environment they want.

The TOY environment has been designed to support basic education, but its use and applicability are by no means limited to this. It can similarly serve as a learning environment in institutes of higher learning, support work, management and training in the corporate world, and provide customized services to specific user groups, such as the disabled. A good learning environment, whether traditional or virtual, seeks to create interest and motivation in the topic under study, provide a user-friendly environment for data handling and thereby promote learning. The learner is in the centre, and the other resources support his or her learning requirements. Here virtual worlds are especially beneficial, because they are not constrained by the rules and operational models of the traditional world, or the representations thereof. The same change that has been realized in the virtual 3D game-like environment also works in the real world. When developing virtual environments, physical and virtual go hand-in-hand. Both require attention. In order for a change to happen, things need to be shaken up a little - people need to be challenged to find new ways of thinking and acting. Only then it is time to see how the change can be implemented in practice. Visibility is important for achieving common goals. In the final phase the work leads to a change in the whole operational culture and affects the pedagogical models used. The change does not happen automatically, and you have to start somewhere. The first step is deciding that it's time to make a start! Help is available, and the use of outside expertise improves the odds of success.

The virtual image created resembles the authentic operational learning environment as closely as possible, and forms a learning community. From the student's point of view, the new learning environment is like a 3D user interface containing personal data, web-based data retrieval and personal learning resources, which can be accessed through ubiquitous technology. A real world-like virtual learning environment is implemented by building a future school space that is representational, but a game-realistic image of the future environment, such as a communal lobby or a future learning environment. The space is equipped with learning and interaction tools enabling research and small group learning.

The environment acts as an extension of the school and provides open interfaces to teaching activities, including, for example, mobile contents, game-like exercises and simulations. Once completed, the operational environment serves as an educational game-like entity that can later be expanded and linked with various learning and teaching services. The environment can be dynamically configured. In development of TOY environment the aim is also to furnish the virtual world with solutions that accommodate future learning environments and that provide relaxing and comfortable learning experiences. The space encompasses virtual walls where users can share information and increase common knowledge. Game-like learning environments motivate users and evoke interest towards the kind of knowledge building that they themselves deem important.

2. The TOY learning spaces

The virtual world and learning environment to be built provide a service that supports the learning of comprehensive school-level students by encouraging time-phased project work in a game-like environment. The application has been defined together with pedagogical and technical experts. The learning environment encompasses modes or processes that are not constrained by traditional learning environments and enables learning that is inquiry- and phenomenon-based, cross-disciplinary and creative and project like. The environment is a formable 3D space where users are represented by avatars, their virtual identities. An avatar is a personal user interface to information and learning. The basic principle in the learning environment is that the avatar looks as natural as possible and is bound by the same collective rules as in the real world. Through this e-identity the user can handle, store and share personal or group-specific information, demonstrate what he or she has learned, and in the future also receive valuations. Based on the modifications to traditional, physical environments, future learning requires three types of spaces: common areas, more private working spaces and personal practice rooms. Thus TOY encompasses a communal lobby, a cooperative learning space and a private sandbox space.

2.1. TOY communal hall

The central lobby is a common assembly area or cafeteria-type space that is adjustable and modifiable depending on its intended use. It is a meeting place meant for all. Its design is static and informative, but it can be utilized in exhibition-type demonstrations. It adjusts the least and modification of its contents requires a higher-level authorization. Above all it is a social, communal thing. The lobby is a big, open space, much like the entry hall of a school (Figure 3). It is dominated by the tree of knowledge, a living entity. The tree can house social media-type links. The lobby has bridges that connect it to more traditional learning solutions, which are familiar to the real world. These include a gallery, a stage and various platforms. They work like Lego blocks; in other words, they can be connected in any manner depending on the need and requirements. The general appearance of the lobby is open and spatial. It can be used for a variety of purposes by adding structures. Its structure is light, wall-less. Adding walls makes it less adjustable. The floor can be easily converted into many types of spaces with many kinds of activities.

Figure 3. The TOY communal lobby space with tree of knowledge, hall ghost and a user (avatar).

The centre of the lobby is dominated by the tree of knowledge. Its fruits can bear information. An image, text or web link can be attached to a vacant fruit. Occupied fruits can be assessed and commented upon with the ‘like’ function, which in future could change the graphics of the fruit. The best, “ripest” fruit could then be collected into a gallery for everyone to see. The purpose of the tree is to make data collection a social process. Its branches could reflect different topics or themes, perhaps arranged by the different school subjects. In addition, the lobby houses a video wall, to which users can link videos from different services and formats. Red ghost is an example of an informative lobby servant. In the initial versions its duty is to deliver aphorisms of the day. Yellow lobby ghost is a data ghost that asks questions, collects answers and prints joint feedback on a specific board. The use, tasks and appearances of the ghosts are provided as examples. They offer many options to develop the environment’s functionality. From central lobby area, you are able to find more co-operative learning spaces, like picture gallery, literature gallery and stage or rostrum area for various learning purposes designed by learner.

2.2. Themed class

Themed class (Figure 4) can be compared to a classroom or a learning community. It is a 21st-century learning environment that can be easily equipped and adjusted for a specific topic or group. The space is loaded with content that is cooperatively studied. In the learning space the download content enables teachers to transform the learning environment into one that best accommodates the situation. Additionally, the teacher or instructor can access processes and build scenarios in their own personal working space, where they can work in peace and quiet before the students enter and the course starts. Sessions can be started with a blank slate (tabula rasa) or a scenario completed during the previous lesson. The students can save the different stages as the work progresses. They can compile information and create presentations. They can retrieve information on the topic and use that to build a presentation, which can be a link, image, test, sound, simulation or mobile observation. It is also possible to build information together. Uses of themed class include for example time line or space simulations.

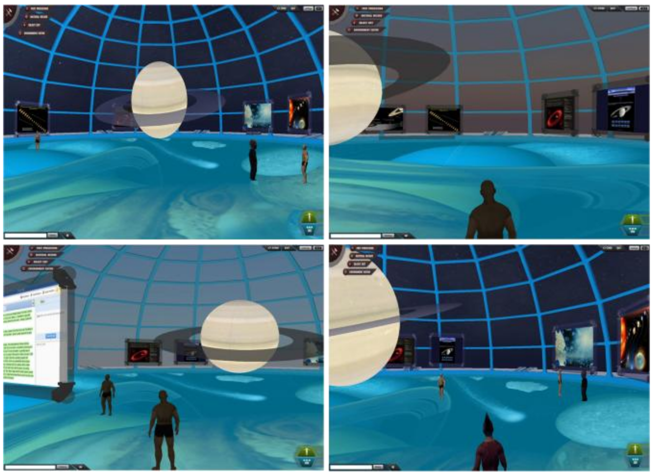

Figure 4. In the themed class space, users can interact with each other and discuss the theme class content.

2.3. Sandbox

The central lobby and the themed class landings are a particular size and there the user can create their own content. The best way to do this is in the Sandbox space which operates as a model of a personal working environment. Teachers have their own teachers' lounge where they can plan sessions and courses. When the environment is further developed, pupils and teachers will have more personal working environments which can be customized to meet the needs of the user. When creating future learning environments, new operational models are central: flexibility, adaptability and rapidly changing situations. Clicking one's fingers or teleporting takes us from one situation or event to another. Although TOY has been developed for comprehensive school learning situations, it offers similar possibilities for institutions of higher education or companies as presentation and training environments.

In the Sandbox, there are different layers of working landings on top of the base area. They are designed to reflect the real world. When we step into a meeting room or any working environment, we select a seat or a workstation and we can use this area as long as we need to work. Others can visit the area to view and leave comments whilst respecting our work. The user has access to appropriate tools to produce content and when the work is finished to save it. Saved work is downloaded into the Library. After saving, they can be dragged and dropped into any compatible realXtend world. A central Sandbox principle is that basically nothing is ready. When a user starts to build own content, the extent of the project determines the size of the area selected by the user. Content is created by using the content tool, which includes links or interfaces to almost any useful application but as a default it has installed the basic features needed for working: web page, picture, EtherPad chat, 3D headings, sound, group creation and mobile observations. In addition to the user's own saved work, they can save useful objects such as platform structures or their framework, the learning base. Objects can be imported into the environment by dragging and dropping. Individual pieces of saved work or objects form a scenario by combining and linking them together.

3. Role of avatar

In real life we operate through our own identity, and are frequently asked to prove it by presenting a passport or a driving license. Everything we do, write or say is linked to the self. It represents an individual's thinking and builds their personality, which lives and evolves through that individual's actions. Why, then, should things be any different in a virtual world? The things that an individual does though their avatar represent and portray that individual to the outside world. In the virtual world, rules of conduct and modes of communication are not yet refined, and apart from normal rules of behaviour, users cannot resort to traditional ways of cooperation in 3D learning environments. We practice common rules and practices all the time, both in schools and other learning environments, so why would we be afraid or shy about doing the same in a virtual world? The young are not as prejudiced as adults, and their actions are not limited by the regularities and societal roles of their parents; besides, in the virtual world, some of the rules and roles are of no importance to learning.

The realXtend environment currently has a group of ready-made avatar profiles that users can modify as they see fit. Skin color, clothing, distinctive marks and even the size of the avatar are adjustable. Another option is to order a customized avatar to match the desired look. In the future, features such as movements, facial impressions, emotional states and personal skills will be more easily modified, which in turn will facilitate non-verbal communication in virtual spaces. Avatars are an important, if not the most important, element in the virtual world, and users take great care in creating them (Figure 5). For some, the appearance of their avatar is insignificant and they opt for standard avatars and clothing. One way of getting your message across is to dress the avatar accordingly. The most extreme and realistic approach is to take a photo and project it on the virtual environment, and thus make the interface to this world a true copy of the real one. Everything you say in the real world you must be able to also say in the virtual world and with your own identity.

Figure 5. Role of avatar individually and as part of teamwork.

3.1. Nonverbal communication in 3D virtual learning environment

How to get the teacher's attention in a virtual environment? As part of the School of the Future program, the significance of the InnoAula as a physical learning environment as well as the TOY as a virtual learning environment was studied from the aspect of interaction and non-verbal communication. The purpose of the research was to find out how to increase a sense of community and true and versatile interaction in e-learning. Another objective was to come up with functional and realistic ideas for the virtual environment that are also applicable to real schools.

Nonverbal communication has a significant role in human interaction. It can be seen as a "communication coding system" and it's meaning to form impressions and expressing emotions is huge. It also has a role in promoting turn-taking management and giving feedback during interaction. In fact, studies have shown that the most of the people are dependent on nonverbal clues during interaction and they form their impressions from others on the basis of these signals. There are seven categories of nonverbal signals: kinesis, vocalics, physical appearance, haptics, proxemics, chronemics and artifacts. From the above-mentioned categories, kinesis (bodily movements, facial expressions, gesture etc.) and vocalics (paralinguistic features like loudness or tempo of voice) are used most widely and they identify their user more than other nonverbal signals. [16] Nonverbal communication can be seen just a part of human interaction in which case it includes all communicative elements except words between those present. It also can be understood more widely involving all perspective of culture like built environment [15].

From the beginning of the computer-mediated communication (CMC) research one of the key interest has been nonverbal communication. In 3D virtual environments the research has focused on use of avatars and their ability to convey nonverbal signals [15][14][18]. Studies have shown that opportunity to use nonverbal signals via avatars have a huge impact on feeling of social presence which has positive influence to quality of interaction. Avatar's main functions seem to be to identify users as well as promote and support interaction by increasing group awareness and displaying communication cues. [14]

Although 3D virtual environments and avatars have given more possibilities to use nonverbal signals during online interaction it is important to notice that nonverbal communication in virtual worlds is different than in physical world. In fact, there are two kinds of nonverbal signals in 3D virtual environment: computer-generated (or predefined) and user-generated. The studies have shown that computer-generated nonverbal cues can cause confusion because they are unnatural whereas user-generated are created by users themselves and they can improve the quality of interaction [15]. Some of the nonverbal signals like proxemics (use of space, distance etc.) and chronemics (use of time as a message system) can be used in 3D virtual worlds but power of these signals is decreased [16]. Still proxemics have important role during interaction in virtual world. The spatial dimension and synchronous communication are the key elements of enhanced interactivity in virtual worlds [18].

Social presence is a social factor that is essential both in face-to-face and online interaction. Nonverbal communication impacts substantially to emergence and maintenance of social interaction. [17] Therefore it has a big role in maintaining students motivation and supporting interaction during learning situations in virtual environments [14].

4. User studies of the TOY virtual 3D Learning Environment

The first User Experience (UX) study for TOY environment, was carried out in the primary school with language club pupils. User experiences were studied also with lower and upper secondary schools. In primary school, the TOY environment was used by pupils as part of language club activities. The purpose was to develop language and the way it is used in different situations, starting with a word and a sentence, and ending with writing a story jointly. There were 11 participants overall, whose age varied from 10 to 12 years (2 boys, 9 girls). 11 pupils participated in the first test and 6 of them also in the second test session. In secondary school, the pilot project involved study guidance and practical training. Several teachers besides the careers counselor participated in the project: teachers of information and communication technology, mathematics and languages. Experiments were conducted in lower and upper secondary schools with 19 pupils and students. Their age varied from 16 to 18 years.

The UX studies indicated that the virtual school can be a great environment for group and collaborative learning. Therefore, 3D virtual learning environments should be evaluated with multi-group settings in collaboration with different schools and countries. Our short experiment with the language club pupils and teachers elicited the important benefits 3D virtual schools can bring to language learning and international communication. Pupils can interact easily with other people from different cultures and language areas. This brings real value for language learning. The study elicited also that an important requirement for a virtual school is to provide good game-like elements such as games that make learning easy and fun. Pupils can play interesting educational games and learn at the same time. However, this does not mean that the virtual school is just a space for games. Instead, the idea is to enrich learning and teaching methods by utilizing new technologies. The TOY spaces were developed based on the earlier studies of physical spaces of real learning environments. Our UX experiments indicated that it is important to have similar private and public spaces and objects also in virtual environments like those in the physical world. However, in 3D virtual environments it is possible to bring new elements in the world and use them in teaching, for instance, study phenomenon of physics by using 3D models. One main benefit of extensible 3D virtual environments is the possibility to create, modify and share one's own content. For instance, each school could create different material in the world and then lead pupils to use them based on their skills and interest, not only based on the age group. [19]

Another experiment regarding the monitoring of learning was carried out in collaboration with the LearnLab Research Centre of the University of Oulu. The TOY virtual environment was connected to the equipment that analyses eye movements (Figure 6). The equipment has been used only in a few experiments so far but several research parameters are available.

Figure 6. Images of the eye monitoring of the TOY environment captured by TOBII eye monitoring system.

According to the first observations, reading text in frames or tables in a virtual environment is very similar to reading a book. Eyes follow the text in the same way. A virtual environment only shows its potential when users can move and learn in the environment. Instead of reading text in lines, one looks for different objects and observes the surrounding environment, exactly like in the real world. When we operate in a virtual world through avatars, we reflect real experiences to the learning environment. These experiences provide a useful basis for developing virtual environments and their contents. They also help define what kind of contents should be uploaded in a virtual environment to support learning. Another interesting observation was the importance of the former experience of users. A novice operated in the environment in a different way than more experienced users. Users can only operate in an environment once they are familiar with its basic functions. After this they pay more attention to the functions than to the environment. The equipment used in the experiment helps find out which direction the user looks at and how long they focus on certain details.

5. Conclusion and future work

While developing the TOY learning environment of the future we have only managed to scratch the surface. A virtual, 3D, game-like learning environment is an interesting and global prospect for learning and has a great number of possible applications. The development work of the TOY environment has been strongly connected to the development of the realXtend platform, and these have had a positive effect on each other. The TOY environment has been built on the basis of pedagogical content and technological tools, and the result is a functional entity that supports a modern concept of learning and of schoolwork to achieve goals. Game-like qualities further improve the environment.

In future, the prospects of such environments can be put to further use in the design and development of traditional and modern learning environments as well as the modeling of existing school buildings. Thanks to Cave-like spaces and solutions, users can see the possibilities of the real world through a virtual one, and they can participate in the development of their surroundings. When more precise modeled plans of work environments are created, their properties will become part of the learning environments. Moreover, it is possible to build simulations and sub-games to motivate users and make them practice different kinds of situations in the context of a learning environment.

The real and the virtual world are brought closer to each other through mixed and enhanced reality applications. The import of modeled objects and interfaces into the real world and the way they connect us to the virtual world change our ways of using learning environments and generally enliven the learning processes. In the future, we will most likely be able to dictate what happens in the real world through a virtual one. A virtual world contains the previous e-learning tools, and these will provide an interface to learning and knowledge for the next generation. Time will tell what kind of equipment we will use to process data, but mobile devices and interactive display units clearly seem to be the future trend.

The strength and the future of virtual worlds lie in the social space which emphasize functionality. People meet in these spaces, traditional or virtual, and through these meetings they can learn things and create networks. In the future studies it would be useful to conduct more experiments with different age groups and use cases, for example, relating to music training scenarios. Our user experience studies elicited an importance for international co-operation between schools from different countries. International 3D virtual school would bring a rich dimension on pupils' language learning. Also in the future it is important to study mobile and context-based learning in parallel with virtual school use. The most important action in the future is to put forces on long-term user experience studies in order to improve use and learning experiences of virtual 3D learning environments.

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Designing the virtual self: How psychological connections to avatars may influence education-related outcomes of use

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Abstract. The present paper examines how two important facets of avatar design – customization and personalization – may influence users' psychological connections to avatars and education-related outcomes of avatar use. Responses from students who engaged in collaborative learning within a virtual environment suggest that avatar design does influence psychological connections to avatars, that the various measures of such connections included in this project are interrelated in notable ways, and that these connections may influence education-related outcomes of virtual world use. More specifically, this research suggests that virtual environments may best facilitate education-related outcomes by encouraging psychological projection of personality characteristics onto avatars as well as body-level connections to avatars, but limiting extreme avatar customization and personalization.

Keywords. Virtual worlds, avatars, self-representation, self-presence, virtual groups, virtual education

Introduction

Virtual environments and video games are being increasingly used as educational tools. Many of these media include virtual self-representations (i.e., avatars). The ways that users design their avatars vary greatly according to the specific virtual environments in which the avatars exist [1]. Some virtual environments facilitate highly realistic avatars about which the user can make many design decisions. Others only offer a few choices of preset avatars. While others allow users to paste digital pictures of their own faces onto the avatars' heads. The present paper examines how two important facets of avatar design (customization, personalization) influence users' psychological connections to avatars and education-related outcomes of avatar use.

Various aspects of avatar use have been found to influence the users' behaviors and attitudes. For example, variations in the extent to which an avatar resembles its user have been found to influence the users' health of eating [2], exercise [3], racial bias [4], and own body size judgments [5], while avatar height, attractiveness, and clothing color have been found to influence negotiation, social confidence [6], and group cohesion/aggression [7], respectively. These examples utilize experimental paradigms in which participants are assigned to a specific avatar type. This approach

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generates valuable insights into the ways that certain avatar attributes affect users, but lacks external validity because most real-world cases of avatar use allow the users to choose or design their avatars to some extent. Further, these studies rely on the assumption that the avatar users feel psychologically connected to their avatars in some respect, but they do not utilize a standard framework of connection to avatars, thereby limiting the ability to generalize findings to other virtual environments.

A separate line of research addresses these issues by examining the relationship between avatar design choices and avatar users' feelings of connection to their avatars, but these studies also do not utilize a standard framework of connections to avatars. For example, avatar attractiveness and idealization were found to reflect avatar users' personality traits [8], depression/self-esteem [9], sense of self [10], and attachment to their avatars [1]. This line of research contributes to an understanding of the relationship between avatar design and feelings of connection to avatars. However, because such connections are not presented within a standard framework that applies across virtual contexts, it is difficult to extrapolate how such psychological connections may influence behavioral and attitudinal outcomes of avatar use.

The present paper attempts to bridge the gap between these two lines of research by examining the relationship between facets of avatar design (customization and personalization) and two standardized approaches to understanding users' connections to their avatars. One approach is based on the concept of self-presence, which describes such connections as they relate to the user's body, emotions, and identity [11]. The other approach focuses on the concept of avatar personality similarity, which describes the extent to which avatar users perceive their avatar to have personality traits that are similar to their own. Multiple studies have examined and established self-presence as a useful concept within a variety of virtual contexts [12-15], and concepts similar to the present idea of avatar personality similarity has received some attention [1, 9], but self-presence and avatar personality similarity have never been compared to each other. Thus, the exploration of the relationship between them will contribute to an understanding of how numerous types of connections to avatars are related to each other and thus may similarly influence avatar use outcomes.

1. Avatar Attributes and Self-Presence

1.1. Avatar Customization and Personalization

Although avatar customization and personalization have been regarded as interchangeable concepts in previous literature (e.g., [1]), the present paper treats them as two distinct but related attributes of avatar design. Both are manifested when the avatar user makes decisions about how to design the avatar using the tools available within a specific virtual environment. Avatar customization is defined as the extent to which the user has made decisions about the avatar's appearance and attributes (e.g., profile). Avatar personalization is defined as the extent to which an avatar resembles the user. The more decisions made about the avatar's design, the higher customization. The more an avatar resembles the avatar user, the higher personalization.

Given this definition, avatar customization and personalization are sometimes, but not always, positively related. If an avatar user utilizes many modification options to make the avatar resemble herself, then this avatar has a high degree of customization and personalization. However, an avatar user may also utilize many modification options but create an avatar that does not resemble herself (e.g., an avatar based on a fictional character). Alternatively, it is also possible for an avatar user to create an avatar that resembles herself without utilizing many modification options, for example, by pasting an image of her own face taken from a digital camera onto the avatar's head.

Although previous research has not examined the distinctions between avatar customization and personalization as defined here, there is a growing body of research on the choices that people make about their avatars. All of these studies utilize independent variables that relate to avatar customization and personalization as offered here. Lim and Reeves [16] found that merely making a choice of avatar out of a few preset options, as opposed to being assigned to one of the avatars, led to stronger physiological responses during avatar use. This represents a case of low customization and no personalization. Jin [10] found that participants who were instructed to design an avatar to reflect their ideal self experienced greater feelings of interactivity during avatar use than those who designed an avatar to reflect their actual self. This represents a comparison between two types of personalization while holding customization constant. Moving away from the experimental paradigm, Bessiere [9] found that online gamers tend to design avatars that reflect their ideal self more than their actual self and that this finding holds for people with depression and low self-esteem. This represents a comparison between two types of personalization moderated by psychological health. And in what may be the most in-depth study within this area, Ducheneaut et al. [1] found that across multiple virtual contexts, hairstyle is one of the most important facets of avatar customization. Different demographics of avatar users value different styles of avatar presentation, and smaller psychological differences between the self and avatar are associated with stronger attachment to the avatar as well as amount of time using the avatar. This study represents a comparison across a variety of customization and personalization options, some of which are overlapping.

If these study examples had utilized standard concepts of avatar customization and personalization, their results could be more easily generalized across virtual contexts. The present paper offers a step in this direction by comparing these concepts to two frameworks for understanding the ways people connect to their avatars.

1.2. Self-Presence and Avatar Personality Similarity

The concept of self-presence was initially described as a virtual world user's mental model of various facets of herself within the virtual world [17], but a robust definition and operationalization of self-presence was not introduced and examined until recently [11-15]. The present paper draws from this recent work, which provides a means of standardizing our understanding of the ways people connect to their virtual self-representations across virtual environments. Broadly, self-presence is the extent to which an individual's self is relevant during media use. More specifically, there are three levels of self, derived from a neuroscientific framework of self [18, 19], that can be relevant during avatar use: proto (body), core (emotion), and extended (identity). Each of the levels can be considered individually, though all three are interrelated [13, 14]. The present paper focuses on the two most examined and relevant of these levels, proto and extended self-presence. Proto self-presence is defined as *the extent to which a mediated self-representation is integrated into body schema*. High proto self-presence implies that the self-representation is treated as an extension of the body without conscious consideration of the media interface. Extended self-presence is *the extent to which some aspect of a self-representation is related to some aspect of personal* *identity.* High extended self-presence implies that the self-representation reflects important aspects of personal identity. The self-presence questionnaire (SPQ; [20]) has been used to examine the reliability, validity, and usefulness of self-presence across numerous virtual contexts, including collaborative virtual environments [12, 13], online multiplayer games [15], and movement-based console games [14, 20].

The present paper contributes to an understanding of self-presence as it relates to the facets of avatar design described earlier, i.e., customization and personalization. In a recent study, participants who designed an avatar to resemble themselves using in-game tools reported higher levels of extended self-presence than participants who were assigned to use a generic avatar [14]. In other words, people who used personalized avatars reported more extended self-presence than people who used avatars that had been neither customized nor personalized. This finding should hold across virtual contexts because avatars that resemble the self are likely to reflect aspects of the avatar user's identity regardless of the context. This leads to the following hypothesis.

Hypothesis 1: People who use personalized avatars will report more extended self-presence than people who use avatars that have not been personalized nor customized.

The relationship between avatar customization and extended self-presence is not as straightforward. Although someone may invest a high amount of customization into an avatar, the avatar's characteristics may not necessarily reflect any aspects of the user's identity. However, previous research has found that most avatar users tend to design avatars that resemble themselves in some respect, such as gender [21-23]. Further, although there are a small minority of people who "role play" regularly [24], in general people find it difficult and psychologically taxing to portray false identities through their avatars [1]. In other words, while customization does not necessitate personalization, people generally do personalize their avatars to some extent when given the ability to customize. Thus, if Hypothesis 1 is supported across virtual contexts for avatar personalization, then it should also be supported for avatar customization. This leads to the following hypothesis.

Hypothesis 2: People who use customized but not highly personalized avatars will report more extended self-presence than people who use avatars that have not been personalized nor customized.

Avatar customization and personalization may also relate to the other two levels of self-presence in predictable ways. In the same experiment as described above, participants who designed an avatar to resemble themselves using in-game tools reported higher levels of proto self-presence than participants who were assigned to use a generic avatar [20]. This finding is potentially explained by the physical similarity between a highly personalized avatar and the user, i.e., the more the avatar looks like the user, the more the user feels connected to the avatar on a body level. This explanation is consistent with neuroscientific research that non-body parts are integrated into body schema more easily when those non-body parts resemble the actual body part in appearance or are oriented realistically [25-27]. Thus, the same relationship described in Hypothesis 1 is expected for proto self-presence.

Hypothesis 3: People who use personalized avatars will report more proto self-presence than people who use avatars that have not been personalized nor customized.

The relationship between avatar customization and proto self-presence is not likely to be as strong. Although avatar users generally personalize their avatars when able to customize, in most virtual worlds it is difficult to make the avatar truly resemble the user. As described earlier, there are some virtual worlds that allow for a high degree of personalization without a significant amount of customization, by giving users the option of putting a digital image of their own face on the avatar's head. Thus, when comparing people who use this type of highly personalized to people who use a customized avatar without this type of personalization, those in the former category should experience higher levels of proto self-presence.

Hypothesis 4: People who use personalized avatars will report more proto self-presence than people who use avatars that are customized but not highly personalized.

1.3. Avatar Personality Similarity

Previous studies have compared an avatar user's perceptions of her own personality and of her avatar's personality [1, 9]. The present study offers a term to describe this concept, avatar personality similarity, and defines it as the extent to which a user's personality is similar to the user's perception of her avatar's personality.

The studies that incorporated this concept utilized similar operationalizations. Participants responded to versions of the Big Five personality inventory with respect to their own and their avatar's personality [1, 9]. The researchers then took the difference between the personality measures for the individual and the avatar. Smaller differences indicated greater avatar personality similarity between the user and the avatar. In both studies, participants idealized their avatars' personalities more than their own. Further, Duchenaut et al. [1] found that people with greater avatar personality similarity were more satisfied with and attached to their avatars. They also found that people who spent more time playing as their avatar also reported greater avatar personality similarity.

These findings suggest that avatar personality similarity should be related to self-presence. However, there is no precedent on which to base a prediction about if this relationship is causal and whether this relationship should exist for all levels of self-presence or a subset of them. Further, given that avatar customization and personalization are expected to relate to the levels self-presence in unique ways, it is possible that these facets of avatar design interact with the relationship between self-presence and avatar personality similarity. Again, there is no precedent on which to base a prediction about such potential interactions. Thus, these relationships are examined within exploratory research questions.

RQ1. Is there a relationship between self-presence and avatar personality similarity?

RQ2. How do the relationships between self-presence and avatar personality similarity differ according to avatar customization and personalization?

1.4. Group Processes

People often use avatars to interact with others in virtual environments. In some cases, the goal of such social interactions is learning. Virtual worlds present excellent platforms for collaborative learning because they can bring people together from geographically and culturally diverse locations and facilitate the sharing and construction of knowledge within these groups [28]. Facets of avatar design and psychological connections to avatars may influence people's attitudes about their virtual groups [29], thereby affecting the output of such groups [30] – their collective development – as well as individual learning [31]. Thus, it is important to understand the role of avatar design and psychological connections to avatars in such education-related virtual group processes. The following research question reflects this inquiry.

RQ3: Is satisfaction with a collaborative learning task in a virtual group affected by facets of the group members' avatar design (customization, personalization) and/or psychological connections to their avatars (self-presence, avatar personality similarity)?

2. Method

2.1. Participants, Materials, and Procedure

Participants included 155 students (120 male, 35 female) between the ages of 19 and 42 (M = 23.51, SD = 2.69) who collaborated in four to five-member virtual teams throughout the Fall 2010 semester. The study was conducted in the context of a global lecture series called "The ShanghAI Lectures" (http://shanghailectures.org) on embodied – natural and artificial – intelligence. The lecture series by the Artificial Intelligence Lab of the University of Zurich (presented for the first time in Fall term 2009 from Shanghai Jiao Tong University) connects about 15 universities worldwide every year via videoconference. The students collaborated on group assignments as avatars in a virtual world named "UNIworld" over the course of the semester, which was developed based on the open-source toolkit "Open Wonderland" (version 0.5) (http://openwonderland.org). In addition to group exercises, participants participated in bi-weekly discussion sessions with their lecturer within the virtual environment. UNIworld offered public and private chat and "spatial audio" (i.e., automatic volume adjustment according to the distance between avatars). Further, a set of 14 basic postures and gestures were provided that students could perform through their avatars using keyboard commands or by clicking corresponding buttons. Collaborative work was supported by in-world application sharing tools, such as web browsers, video-players, PDF viewers, text editors, and whiteboards. In addition to the collaboration platform, teams could use additional media to schedule meetings and coordinate tasks.

Students were given the option to use a default avatar, a customized avatar using in-world tools, or a personalized avatar with a picture of their own face on the avatar's head. Participants began with a cartoon-style default avatar and were given the possibility to customize gender, clothing accessories, and color of skin, hair, pants, shirt, and shoes. In comparison to other virtual world applications (e.g., *Second Life*), the freedom to customize avatar appearance was limited in UNIworld. These customizations were categorical and did not allow for gradual changes. In order to create a personalized avatar, students used a special website that facilitates the creation of photorealistic avatars (http://evolver.com). Students could upload a photograph of themselves, export the avatar file from evolver.com, and then import it in UNIworld and use it as any other Wonderland avatar (i.e., navigate, speak, and write).

Upon registration for the lectures, the students were requested to choose an avatar name and to fill in a profile page on the course website. The online registration form contained a description of the purpose of the research project, the kind of data to be collected, and privacy protection procedures. The students were also required to read and respond to an informed consent form. Participation in the research project was an optional part of the lectures, which had no bearing on their academic evaluation.

Participants responded to two surveys throughout the course of the project. The first, which was administered after the first group exercise, included questions about demographic information, technology use habits, and psychological personality traits of the participant. The second survey was administered after the final group exercise, about six weeks after the first survey. This included questions about the collaborative experience, type of avatar used (e.g., default, customized, personalized), self-presence (i.e., the SPQ), and psychological personality traits of each participant's avatar.

2.2. Measures

Avatar type was determined by responses to the questions "What kind of avatar did you use in UNIworld?" and "How often did you use a personalized avatar that you created on evolver.com based on your photograph?" 41 participants responded with "customized" to the former and "never" to the latter, while 36 responded with "occasionally" or greater to the latter. Thus, the former were classified as customized avatar users and the latter as personalized avatar users. The remaining 77 were classified as default avatar users.

The self-presence questionnaire (SPQ; [12-15]) was used to measure self-presence. Individual items for proto and extended self-presence were averaged to form composite measures with Cronbach's alphas of .91 and .83, respectively.

Avatar personality similarity was measured in a similar method as [1, 9]. Participants responded to questions about certain traits as they applied to themselves (first survey) as well as their avatars (second survey). The absolute value of the difference between these scores indicates the extent to which the ratings of the avatar differed from the ratings of the self. This value multiplied by negative one yields the measure of avatar personality similarity, for which larger values indicate more similarity and smaller values indicate less similarity. The specific personality questions differed from those used in previous studies [1, 9]. Instead of the Big Five personality inventory, a measure of psychological gender was used because gender is strongly associated with physical attributes and thus easier to associate distinctly with an avatar than psychological traits that may not be apparent in appearance. Participants used a 5-point Likert scale, ranging from "not at all" to "extremely", to respond to 22 adjectives taken from the personality, cognitive, and physical components of Diekman and Eagly's [32] measures of masculinity/femininity.

Satisfaction with the process of in-world collaboration tasks was measured with with five items taken from Suh's [33] Performance Perception Questionnaire. Participants rated five semantic differentials ("efficient – inefficient", "uncoordinated – coordinated", "fair – unfair", "understandable – confusing", "dissatisfying – satisfying") on a 7-point scale. Cronbach's alpha for this measure was 0.81.

Two measures of technology use habits, computer use time and video game frequency, were included as controls because of the potential effect that they may have on choice of avatar type and psychological connections to avatars. Specifically, people who are more comfortable with technology may be more willing to customize or personalize their avatar and may also feel a different type of connection to their avatars than people who are less comfortable with technology. Participants provided an estimate of the number of hours per week they spend on a computer per week and the frequency with which they play computer of video games on a 5-point scale ranging from "I do not play computer/video games" to "every day".

3. Results

A series of Univariate Analysis of Covariance (ANCOVA) tests were conducted in order to examine the relationship between the type of avatar used and the levels of self-presence. The independent variable in each analysis, type of avatar, could take three levels: default, customized, or personalized. The dependent variable for each analysis was the respective level of self-presence. Number of hours spent on a computer each week as well as frequency of playing video games were used as covariates. The effect of avatar type was significant for proto and extended self-presence (Table 1).

Drawing from this ANVOCA test, post hoc comparisons using LSD confidence interval adjustment were used to examine Hypotheses 1-4 and RQs 1 and 2 (Table 2). Both personalized and customized avatar users reported greater extended self-presence than default avatar users, supporting Hypotheses 1 and 2. Personalized avatar users reported greater proto self-presence than both customized and default avatar users, supporting Hypotheses 3 and 4.

Research Questions 1 and 2 called for a regression analysis in which the a measure of avatar personality similarity was entered as the dependent variable and the measures of self-presence and avatar type measures required to test for moderation were entered as independent variables (Table 3). Model 1 contains only the self-presence measures while Model 2 contains all variables in the model. Model 1 suggests that there is a significant positive main effect for proto self-presence on the measure of avatar personality similarity across all avatar types. Model 2 suggests that there is a significant positive effect of both proto and extended self-presence for people who use a default avatar. Further, the negative interaction effect between the customized avatar type and extended self-presence implies that the relationship between extended self-presence and avatar personality similarity is not as strong for people who use customized avatars as for people who use default avatars.

Research question 3 was addressed with an ANCOVA that included the measure of group process satisfaction as the dependent variable, avatar type as the fixed factor, and the measures of self-presence, avatar personality similarity, and technology use habits as the covariates. The results (Table 4) suggest that the measure of avatar personality similarity is positively related to group process satisfaction. In other words, the more similar an individual's ratings of his own masculinity/femininity was to his ratings of her avatar's masculinity/femininity, the higher this person's satisfaction with the group process. Further, the relationship between extended self-presence and group process satisfaction was just nearly significance, indicating that people who felt more extended self-presence were also more satisfied with the group process.

Table 1. ANCOVA Omnibus Tests

	Proto Self-Presence		Extended Self-Presence	
	F	Partial η^2	F	Partial η^2
Avatar Type	10.89 ***	0.00	10.89 ***	0.14
Computer Hours/Week	2.29	0.01	2.29	0.02
Video Game Frequency	0.98	0.15	0.98	0.01
df total	144		144	
R^2	0.15		0.16	

Note: *$p < .05$, **$p < .01$, ***$p < .001$

Table 2. Post Hoc Comparisons

Avatar Type (A)	Avatar Type (B)	Proto Self-Presence: Mean Difference (A-B)		Extended Self-Presence: Mean Difference (A-B)	
Personalized	Default	0.78	***	0.76	***
Customized	Default	-0.09		0.58	**
Personalized	Customized	0.87	***	0.18	

Note: *p < .05, **p < .01, ***p < .001

Table 3. Regressions on Avatar Personality Similarity

	Model 1 Beta	t		Cohen's d	size^	Model 2 Beta	t		Cohen's d	size^
Proto self-presence	0.46	5.54	**	0.93	large	0.29	2.26	*	0.39	med
Extended self-presence	0.16	1.89		0.32	med	0.37	2.89	**	0.50	med
Customized Avatar						0.25	0.92			
Personalized Avatar						0.40	1.29			
Customized*Proto						-0.01	-0.04			
Customized*Extended						-0.62	-2.18	*	-0.17	small
Personalized*Proto						0.23	1.10			
Personalized*Extended						-0.36	-1.00			
df	141					133				
R^2	0.31					0.32				

Note: *p < .05, **p < .01, ***p < .001
^ >0.8 considered large, 0.2-0.8 medium, <.2 small

Table 4. ANCOVA Omnibus Tests on Group Process Satisfaction

	F		Partial η^2
Avatar Type (Default, Customized, Personalied)	0.68		0.01
Proto self-presence	0.60		0.01
Extended self-presence	3.90	p=.05	0.03
Avatar Personality Similarity	9.172	**	0.07
Computer Hours/Week	0.19		0.00
Video Game Frequency	0.453		0.00
df	127		
R^2	0.13		

Note: *p < .05, **p < .01, ***p < .001

4. Discussion

The present paper examines how two important facets of avatar design (customization, personalization) influence users' psychological connections to avatars and education-related outcomes of avatar use. Responses from students who engaged in collaborative learning within a virtual environment suggest that avatar design influences psychological connections to avatars, that various measures of such connections are interrelated in notable ways, and that these connections may influence education-related outcomes of virtual world use.

With respect to the relationship between avatar design and self-presence, both personalized and customized avatar users reported significantly higher extended self-presence than default avatar users, while personalized avatar users reported significantly higher proto self-presence than both customized and default avatar users. This dichotomy suggests that while avatar customization with or without personalization leads to a feeling of identity connection with the avatar, only highly personalized avatars are able to facilitate a body-level connection to the avatar. This supports the claim that physical similarity between an avatar and the user leads to proto self-presence. This presents notable implications for the outcomes of avatar use. For example, given the finding of a negative relationship between proto self-presence and performance on a math task after avatar use [20], the present findings suggest that highly personalized avatars may detract from education-related virtual environments.

The finding that extended self-presence is significantly less related to avatar personality similarity for customized avatar users is notable, especially given that extended self-presence is strongly and positively related to avatar personality similarity for default avatar users. This suggests that when people customize an avatar with in-world tools, they imbue gender characteristics into the avatar that are different from their own. However, when they use an avatar that they have not customized with the virtual world's tools, they psychologically project a gender personality onto the avatar that is consistent with their own. Thus, ironically, customizing the avatar leads to larger psychological *dissimilarity* between the user and the avatar. Future research should examine the effects of psychological projection of personality onto an avatar differ from those of customizing or personalizing an avatar.

The finding that the measure of avatar personality similarity is positively related to group process satisfaction is notable because of its implications with respect to education-related outcomes of virtual world use. In other words, the more similar an individual's ratings of his own masculinity/femininity was to his ratings of his avatar's masculinity/femininity, the higher this person's satisfaction with the group process. Given that group process satisfaction is an important component of collaborative learning, this finding suggests that gendered avatar personality similarity may contribute positively to a virtual world's education-related outcomes. The finding that extended self-presence was positively related group process satisfaction suggests that virtual worlds may be able to augment education-related outcomes by encouraging extended self-presence. However, recall that extended self-presence was strongly related to avatar personality similarity for default but not customized avatars. This suggests that psychological projection (e.g., writing a story about the avatar) may encourage extended self-presence more effectively than customization.

Proto self-presence was positively related to avatar personality similarity, which was related to group process outcome. This may imply that education-oriented virtual worlds should encourage a body-level connection to their avatars, perhaps through avatar personalization. However, previous research found that proto self-presence detracted from performance on a math test after avatar use [20]. These seemingly contradictory findings may suggest that a curvilinear relationship exists between proto self-presence and education-related outcomes. Namely, too little proto self-presence hinders the ability to connect to the material in the virtual world, while too much proto self-presence creates such a strong connection to the virtual world that users are unable to process the education-related material. Future research could test for this curvilinear relationship by inducing different levels of proto self-presence (e.g., through avatar personalization) and examining the related education-oriented outcomes.

Overall, the present research has addressed numerous relationships between avatar design, psychological connections to avatars, and outcomes of avatar use. One important goal of this research has been to offer some standard concepts and terms for research in this area. Another goal has been to synthesize the relationships examined into basic insights about how education-oriented virtual worlds designed for collaborative learning experiences could maximize the pursuit of their goals. While this paper represents a single step toward these goals, this is a valuable area of research will likely improve that ways that we design and learn from our avatars.

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Fighting Drop-out Rates in Engineering Education: Empirical Research regarding the Impact of MUVEs on Students' Motivation[1]

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Abstract: The use of Multi User Virtual Environments (MUVEs) in education is increasing mainly due to aspects related to the motivation of the students. However, more practical research about the impact of MUVEs on students' motivation in real educational contexts is required. In this paper we present empirical research that investigates how several aspects of *NUCLEO*, a pedagogical framework that integrates a MUVE with a Learning Management System (e.g. *Moodle*™), affect students' motivation, in the context of teaching software programming to engineering students. The results obtained suggest that the aspect that produces the deepest impact on student motivation is the introduction of game mechanics in the MUVE, while setting a 3D immersive virtual world as user interface for the game does not seem to have such a great impact.

Keywords: Computer Supported Collaborative Learning, Game Based Learning, *Mare Monstrum*, Multi-User Virtual Environment, *NUCLEO*, Problem-Based Learning,Virtual World.

Introduction

During recent years, instructors of undergraduate studies such as Engineering Education have observed an alarming increase of dropout rates in their courses. To tackle this lack of motivation and improve students' learning outcomes at the same

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Pilar Sancho, Javier Torrente, Baltasar Fernández-Manjón: *Do Multi-User Virtual Environments Really Enhance Student's Motivation in Engineering Education?* In proceedings of the The 39th Annual Frontiers in Education Conference (FIE 2009), 18-21 October, 2009, San Antonio, Texas, USA. Available online at: http://fie-conference.org/fie2009/papers/1560.pdf. 2009 time, several technologies have been proposed [1], including video games [2, 3], simulations [4] or even other approaches fostering student collaboration [5]. Multi User Virtual Environments (MUVEs) are one of the tools that have been proposed. MUVEs are systems that enable multiple participants to interact and communicate concurrently in a virtual world through "avatars" that they use to represent themselves in the virtual world. The use of these immersive 3D environments in education has drawn significant attention mainly due to the ability that MUVEs seem to have to engage people of diverse demographic backgrounds [6, 7].

Probably this increasing interest derives from the hypotheses proposed by a group of researchers [8-10] according to whom traditional textual learning contents do not capture the attention of *digital natives*. This generation of young people, who were brought up in the digital age, is used to interacting with multimedia applications that are, above all, immersive and highly interactive. Technology in general and video games with their appealing graphical interfaces in particular have been part of their everyday lives since they were kids. Therefore the formats of educational applications must be adapted to what digital natives feel more attracted to.

Nevertheless, in spite of the potential of MUVEs for educational purposes, their efficacy in reaching specific learning objectives, compared to other traditional approaches, is still under discussion (as also happens with other state-of-the-art learning technologies like educational video games or social networks). Even the motivational aspects that are usually related to MUVEs have not obtained general acceptance within the academic community. Although several experiments have been performed in this concern [11], there is still little contrasted and accepted evidence in the literature to reach a solid and generally accepted conclusion. This lack of evidence, added to other inconveniences of MUVEs such as high development cost or elevated computer requirements are preventing a more general adoption of educational MUVEs. Therefore in order to clarify these issues more practical research is needed.

The *NUCLEO* project was devised to improve the learning process for undergraduate software programming modules, targeting some of the most common issues that are currently affecting engineering degrees. In this line, one of the main goals of the project is to enhance the motivation of students as a strategy to reduce the growing dropout rates that these modules have been experiencing during the last few years. To achieve this goal *NUCLEO* proposes a role game-based learning scenario, which is implemented using a MUVE and a Learning Management System (*Moodle* ™[2] [12]) which are fully integrated, and which follows a blended learning approach that combines face-to-face lectures and online learning sessions.

The conclusions presented in this paper are the result of analyzing the use of two different implementations within the *NUCLEO* framework. They have been used in several case studies that took place over two consecutive academic years for the same module. The first implementation (*Mundo NUCLEO*) used a free software tool, which included a fantasy game narrative metaphor and a 2D user interface, to promote collaborative learning. The second one (*Mare Monstrum*) followed the same ideas but replaced the 2D user interface with a rich immersive 3D virtual world as user interface. The goal was to analyze the use of a 3D MUVE as a motivation enhancer. It integrates

[2] Moodle™ web site: http://moodle.org/

two existing platforms (*Moodle*™ and *Multiverse*™[3]) and presents a 3D immersive scenario to liven up a game narrative that includes role play dynamics and fantasy.

Both implementations shared the same underlying learning strategy based on the Problem-Based Learning (PBL) paradigm; therefore the only substantial difference between the two systems was the use of the 3D virtual world as user interface.

The paper is structured as follows: First, in section 2 we provide some related work about MUVEs, game-based learning and their connection to engineering education. In section 3 we briefly describe the *NUCLEO* pedagogical framework (which sets the theoretical base for both the *Mundo Nucleo* and *Mare Monstrum* systems). After that, we describe the two different implementations of the *NUCLEO* framework that have been used in this research: *Mundo Nucleo* (section 4) and *Mare Monstrum* (section 5). Next, in section 6, we present two case studies that have been performed to test the real impact that different aspects of the *NUCLEO* approach have on student motivation. In section 7 we discuss the results obtained. Finally, some conclusions and future work are presented in section 8.

1. Related Work

As a consequence of the growing interest in the use of MUVEs for teaching and learning, several initiatives are applying general-purpose MUVEs in education in multiple domains (e.g. *SecondLife*™ [13-15]). Moreover, many virtual worlds have recently been developed specifically for education, thus supporting learning in a wide range of subjects. While some of the most cited examples are oriented to young people in middle and high school, like *River City* [16], *Revolution* [17] or *Quest Atlantis* [18], other MUVEs have been devised for their application in undergraduate and professional training programs, like *AquaMoose* [19] or *AppEdTech* [20]. Finally, a growing body of research reveals the educational and social potential of virtual worlds [21, 22].

Therefore these initiatives do not only target K-12 education, but also higher education. For instance, digital games and MUVEs have great potential in engineering education, as the unique features that these immersive environments have can be aligned with the development of the skills that 21st-century engineers require [23]. Nowadays we can find good examples of applying games in multiple engineering disciplines like chemical engineering [24], civil engineering [24], digital design [25] or electronics [26].

Games and MUVEs offer students the chance to face real-world open-ended problems, which is necessary for engineers, as opposite to classical teaching methods where theory predominates over practice (e.g. combining lectures and Computer-Assisted Design tools). In this regard role-play and simulation games where players must run complex businesses or organizations (e.g. VirtualU™ or the Sim™ or Tycoon™ sagas) are especially adequate for the improvement of future engineers' management skills [27, 28]. For instance, in these games students can play the role of

[3] Multiverse web site: http://www.multiverse.net/index.html. Last access: December 6th, 2009

the manager of a manufacturing company and experience the management of the whole product life cycle and how their decisions affect the results of the company. In this manner games and MUVEs with high simulation levels can foster the acquisition of problem solving skills. Another interesting example in this regard is the use of racing games to learn vehicle dynamics in a mechanical engineering course [29]. In addition, the high level of realism achieved by these technologies allow students to increment their laboratory time and rehearse with specific machinery and equipment that are not always available as many times as desired in a cost-effective manner [30].

In addition, in MUVEs students can interact with other peers in a natural way, enabling the implementation of learning strategies that foster the development of teamwork skills. This is one of the most important abilities that future engineers will require. In fact, many of the initiatives that explore the use of new technologies in engineering education focus on the implementation of advanced collaboration features as one of the most important requisites [31-33].

2. The NUCLEO Project: Overview

NUCLEO is an instructional framework that pursues three main objectives: (1) to improve students' motivation as a way to reduce the alarming growth in dropout rates, (2) to move students towards a more active role in learning, and (3) to help students to develop teamwork abilities and soft skills while they acquire state-of-the-art knowledge and technical skills. *NUCLEO* integrates a MUVE with an LMS using a pedagogical approach deeply grounded in the socio-constructive stream, in which students collaborate in small teams to reach the solution of real-world, open-ended, ill-structured problems as they would do in classical problem-based learning scenarios [34]. The difference is that the real course is represented metaphorically by a fantastic virtual world. Therefore in *NUCLEO*, instead of trying to sugar-coat the educational content as fun (as most game-based learning approaches do), it turns the whole learning scenario into a game and introduces game-like strategies such as cooperation or competition. On the other hand, *NUCLEO* is conceived to be used as a plug-in application over an LMS. Therefore, services, tools and data are managed in a centralized way at the same time, which simplifies its integration in the educational infrastructure [35, 36].

In order to accomplish these objectives, *NUCLEO* uses a Problem-Based Learning (PBL) approach as the underlying pedagogical strategy, where the learning scenario is set in the virtual fantasy world of role games. Therefore, it relies both on a MUVE as user interface and a fantasy narrative metaphor to enhance the motivation of the students using a PBL strategy as the underlying pedagogical basis.

The overall design of the *NUCLEO* system is founded on three basic premises, which are the result of a wide study on the state of the art in e-learning and educational systems:

- There seems to be a fairly general consensus about a global decline in student motivation. A corpus of research blames the dull textual content that may simply not attract the attention of a generation of students who are used to more immersive ways of interacting with digital content [3, 8].

- The labor market is much more demanding today than it used to be just a decade ago. Today's professionals are not only required to have state-of-the-art knowledge, but also to develop social abilities that are essential for teamwork, such as leadership, communication or conflict resolution. Therefore, the educational system should cover these new demands and be adapted consequently.

- E-learning systems, such as Learning Management Systems (e.g. *WebCT-Blackboard*™ [37]*, Sakai*™ [38]*, or Moodle*™ [12]) are here to stay. During the past decade, huge inversions in e-learning systems have been sponsored by public and private educational institutions. Many educational organizations are using modern LMS not only for distance or correspondence learning but also as a complement for traditional lectures (an educational trend usually known as blended learning or b-learning). Those LMS are not only content repositories, but rich web-based systems that provide instructors with tools to track and evaluate the performance of the students, keep a record of each or promote communication and collaboration among students (i.e. collaborative learning). In this manner the integration of MUVEs (and educational games) with LMS may push forward the adoption of MUVEs as educational tools.

To increase the cost efficiency and optimize the educational value of our system, we have designed four different phases in order to gradually check different hypotheses. The case studies that are discussed in this paper were developed during phases 1 and 2:

- *Phase 0*: *Documentation and research* of pedagogical and technological strategies for e-learning systems in order to define the pedagogical strategy and produce the instructional design of the system. This was purely a documentary phase. In this phase the basic hypotheses were also outlined, as well as the back-story and the game narrative.
- *Phase 1*: *Proof of concept*. In this phase we made use of free collaborative-supporting tools for learning environments with a classical 2D UI. The goal was to verify the main pedagogical hypotheses on which the system relies, namely: does the PBL approach embedded in a game metaphor increase student motivation? Is the learning strategy effective in terms of knowledge acquisition? And also, does the collaborative framework help students in practicing soft skills?
- *Phase 2*: *Proof of the effectiveness of the virtual scenario*. The main objective of this phase is to verify the impact of several aspects of the 3D virtual scenario and the avatars on students' motivation. As a result of this phase the *Mare Monstrum* prototype was built.
- *Phase 3*. *Development of the beta system*. In this phase a complete system will be developed and distributed for beta testing in different learning contexts. Due to the high development efforts and investment required, we want to redefine certain key functionality features in the previous phases.

3. *Mundo NUCLEO*: Proof of Concept for the Underlying Learning Strategy

This first prototype for the *NUCLEO* system (*Mundo NUCLEO*), using a 2D user interface, was developed during the aforementioned phase 1 and tested in three different case studies as a proof of concept for the basic pedagogical hypotheses that underly the learning strategy. Particularly: does the PBL approach embedded in a game metaphor increase the students' motivation? Is the learning strategy effective in terms of knowledge acquisition? And also, does the collaborative framework help students in practicing soft skills?

The game metaphor takes the students to an artificial world called *NUCLEO,* threatened by a computer virus called *La Ciénaga*. In this scenario, they play the role of warriors that have to be trained in the weapons of knowledge to fight against the menace. During the training, they are presented with several missions that simulate real attacks against *La Ciénaga*. To complete these missions, they are clustered in groups which make up the crew of the aircraft of a symbiotic spaceship, and they have to collaborate to get to the optimum solution. The collaboration procedure within a group is specified according to a classical PBL schema and the three members of the aircraft have different responsibilities according to the role they are assigned.

Therefore in *Mundo NUCLEO,* social interaction takes place according to two different schemas (competition and collaboration) and at two different levels (individually and in groups). Competition and collaboration are two of the foundations of our system, as they are two of the team-making mechanics that have proved to boost motivation and to improve group dynamics in different learning contexts [39]. The competitive atmosphere is enhanced by publishing individual and team results, using rankings. The collaboration takes place using web 2.0 collaboration tools.

Even if the educational gain obtained with a game or game-like environment is very difficult to assess and evaluate [40], *Mundo NUCLEO* was tested in three different educational contexts with real students and the results obtained were really promising, as we discuss in section 5. At the same time, the methodology proved to be effective in terms of pure knowledge acquisition, as the marks obtained in the exams for that course were significantly higher than for the previous ones (for a complete analysis of these results see [41]). Also, the students declared that they found the system useful for the development of soft and teamwork skills [42].

4. *Mare Monstrum*: Proof of Concept for the User Interface

Mare Monstrum is the second prototype developed following the theories of the *NUCLEO* framework. It integrates two existing technologies: *Moodle*™, which is a popular open source LMS, and *Multiverse,* a MUVE (see its reference architecture in Figure 1). It was developed in order to test those hypotheses of the *NUCLEO* project related to the use of an immersive virtual world as a motivation enhancer. It preserves the essence of its predecessor, *Mundo NUCLEO*, with slight modifications:

- The game metaphor has been slightly modified. The environment has been changed to a medieval fantasy aesthetic, while preserving the old schema. In

Mare Monstrum learning takes place on Dragon Island, which is inhabited by the survivors of an ancient civilization, *the Picts*. Again, they are threatened by a terrible enemy, *The Dark Lords*, who want to destroy all knowledge and plunge their world into darkness. *The Sea Dragons*, the last guardians of wisdom, take on the responsibility to train *the Picts* in the weapons of knowledge. Within this metaphoric frame the game simulates a school of warriors competing to achieve the rank of Dragon Warriors. Students play the role of these candidate champions through an avatar, while tutors play the role of *The Sea Dragons*.

- It uses a 3D immersive interface as the scenario of the fantasy world, whereas in the previous implementation the fantasy elements where recreated by plain text and static graphics. Also, the students are represented by customizable avatars.

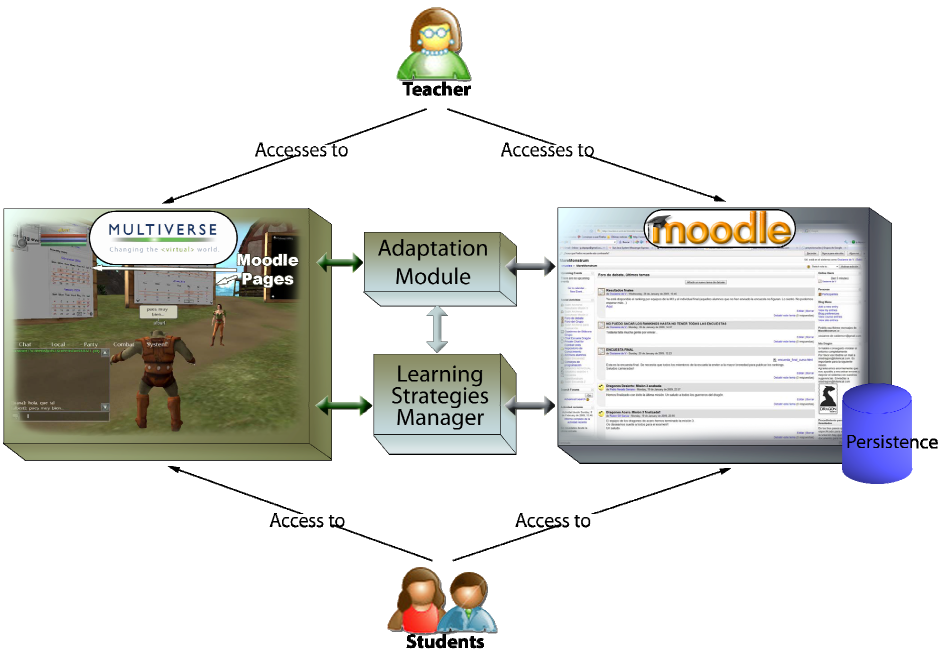

Figure 1. Reference architecture behind *Mare Monstrum*, which combines a MUVE (*Multiverse*™) and an LMS (*Moodle*™). The students and the teacher interact through the MUVE and the LMS, which are fully integrated.

Mare Monstrum supports the competition-collaboration dichotomy by means of two main resources. First, it promotes social recognition through rankings (as it was done in *Mundo NUCLEO*) and rewards students' avatars with physically distinctive characteristics according to the students' achievements (see Figure 2).

Figure 2. A student's avatar that has been awarded a physically distinctive feature (a halo) as a mechanism of social recognition for his/her achievements

Secondly, it addresses the different levels and schemas of social interaction by dividing the virtual world of *Mare Monstrum* into three different zones, with specific tools to facilitate the interaction (see Figure 3):

- *The Pict Village*: area for global interaction. Information panels, such as the mission announcements panel, individual and group rankings, and the public forum are displayed here. These panels are connected directly to the LMS (i.e. *Moodle*), and automatically reflect any change in the MUVE on the permanent record that the LMS stores. All the students have access to this zone, but they can only access the information related to the module they are enrolled in. The course rankings are public for all its members to foster motivation by social recognition (see Figure 3).
- *The Pier*: area for group interaction. A boat on the sea represents a restricted group interaction zone. It is fit out with tools to manage group collaboration, such as private forums, blogs or file sharing facilities (see Figure 3).
- *The Dragon Cliffs*: area for student-tutor interaction. There are two types of facilities at this zone: a zone to send messages to the teacher and a zone in which the tutor can leave additional files for the students (see Figure 3). To force in-game team communication among students in a group only one student per group is allowed to communicate to the teacher. The selection of the interlocutor for each group is done based on the abilities of the students.

It has to be remarked that all these elements were also present in the previous prototype (*Mundo NUCLEO*), in which they were not represented by a 3D environment, but by using classical 2D interfaces for the collaborative tools.

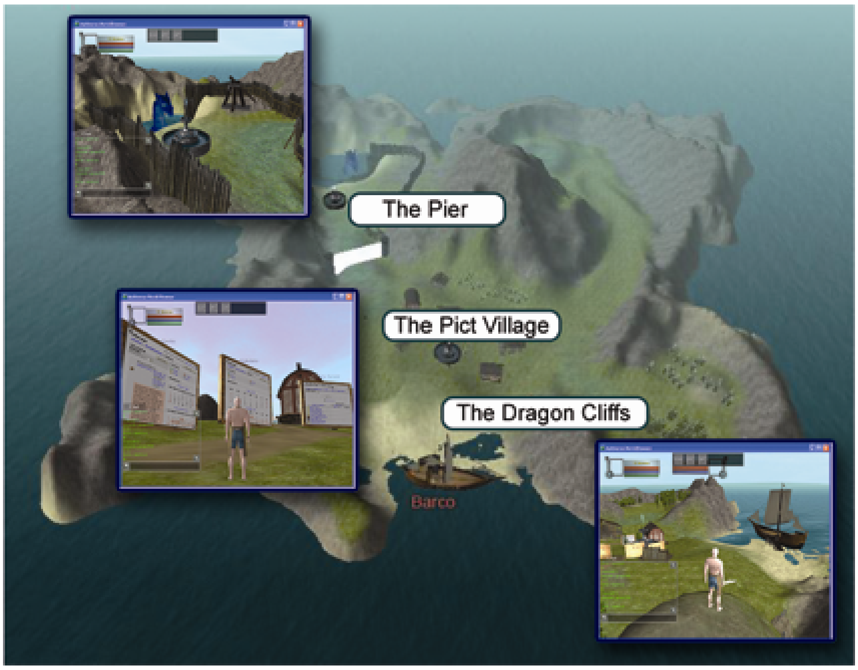

Figure 3. Dragon Island from *Mare Monstrum* with the three relevant areas: The Pict Village, The Pier and The Dragon Cliffs.

5. Two Case studies of *NUCLEO* Prototypes in Engineering Education

So far, the *NUCLEO* pedagogical approach has been evaluated through two different case studies, (phases 1 and 2 as stated in section 2). In the first case study *NUCLEO* was used in a real engineering educational context: the module *Programming Fundamentals* (PF) during two academic years: 2007-08 and 2008-09. During the first year (2007-08) a group of volunteer students used the first prototype, *Mundo Nucleo* (which did not have a 3D virtual world interface). In the second year all the students used the second prototype (*Mare Monstrum*) compulsorily.

In the second case study *Mare Monstrum* was tested by a group of experts and selected users (both teachers and students).

The case studies were designed to evaluate how the next three elements of *Mare Mostrum* affect student motivation:

- The role-game dynamics of the learning scenario
- The immersive 3D virtual world scenario

- Fostering competition amongst the students (either direct competition using rankings and other strategies or using social recognition strategies).

5.1. First case study: Teaching Programming Fundamentals to Electronic Engineering Students

Programming Fundamentals is an optional module of the Electronic Engineering degree at the Complutense University of Madrid (Spain) that students can take during the first year. The goal of this module is to provide students with a general background of software programming by acquiring basic concepts of algorithms, design and coding of programs, etc. The programming language they typically use in this module is C++. Normally in this module a traditional pedagogical approach is followed, combining 2 hours of lectures per week and 3 hours of practical sessions in the computer programming lab. The method to evaluate the learning outcomes of the students in this module takes into account the results of a final test that students must take at the end of the module (60%) and their weekly assignments and participation in class (40%). In order to pass the module students must compulsorily attend the final exam.

Over the last few years, lecturers of PF had observed that dropout rates have increased alarmingly and the grades of the students were going down gradually. This trend suggests a strong decrease in student motivation over the last few years. Therefore the goal of this case study was to test the *NUCLEO* approach in this scenario to analyze if it had a real impact on the motivation of the students.

The indicator used for measuring the evolution of the students' motivation is the average dropout rate, calculated as the percentage of students that attended the final exam at the end of the module in comparison to the total number of students that enrolled in the module at the beginning of the term.

Over the period from 2005 to 2007 (i.e. two academic years), the lecturers in the module followed a traditional teacher-centered approach that included lectures, practical laboratory sessions and a compulsory exam as aforementioned. In both academic years the pedagogical approach followed was exactly the same, as well as the lectures who conducted the module.

In the year 2007-08 an example group (EG) of 22 volunteers followed the NUCLEO approach, combining traditional sessions (lectures, practical laboratory sessions, etc.) and online sessions using the system *Mundo Nucleo* (2D user interface). For the control group (CG) of 38 students the traditional approach was used (identical to the previous years 2005-06 and 2006-07). The students in the EG were released from the obligation to attend the lectures. To interact with other students or with the teacher, they mainly used the virtual world. The evaluation method of the module for the EG took into account both the in-game missions (i.e. assignments) that the students had to solve in *Mundo Nucleo* (40%) and the grade on the final exam (60%).

In the year 2008-09 the complete prototype *Mare Monstrum* (3D virtual world interface) was used by all 54 students enrolled in the course. In this case the pedagogical approach was similar to the EG in the year 2007-08, but some differences applied. The most relevant is that the experiment was mandatory for all the students, as opposed to the voluntary nature of the experiment in the year 2007-08.

Table 1 shows the evolution of dropout rates throughout the 2005-09 period.

Table 1. Statistical data for dropout rates over the 2005-09 period

Academic year	Pedagogical approach	Students enrolled	Students attending the exam	Dropout rate (%)
2005-06	Traditional	115	43	62.61
2006-07	Traditional	110	33	70
2007-08	Traditional	38	13	65.79
	NUCLEO (*Mundo NUCLEO*)	22	20	9.09
2008-09	*NUCLEO* (*Mare Monstrum*)	54	45	16.66

In addition, in 2008-09 students filled in a satisfaction questionnaire on the Likert scale (1= strongly disagree, 2= disagree, 3= agree, 4= strongly agree) to collect their opinion on different issues related to the system. Three questions are relevant to this paper as their purpose was to evaluate the impact that the three aforementioned aspects of the *NUCLEO* approach had on student motivation.

Table 2 shows the results of the survey, merging the percentages of students that agreed and strongly agreed to the questions into one group, and the percentages of students that disagreed or strongly disagreed into a second group.

Table 2. Results of the student satisfaction questionnaire in likert scale

	Students that Disagree or Strongly Disagree (%)	Students that Agree or Strongly Agree (%)
1. I think that this learning strategy based on a **game** makes learning more motivating than a traditional, lecture-based strategy	4.65	95.35
2. I think that using a **3D immersive virtual world** to represent the metaphor of the game makes learning more motivating	44.19	55.81
3. I think that **competition** makes learning more motivating	34.88	65.12

5.2. Second Case Study: Evaluation by Experts and Selected Users

In the second case study that we considered, the *NUCLEO* approach was evaluated by 22 experts and selected users (8 teachers and 14 selected students). All the teachers selected (professors of Software Engineering and Artificial Intelligence at the Complutense University of Madrid) were experts in the design and development of e-learning applications and had proven experience in conducting modules of software programming.

All the students selected claimed to be fond of playing digital games or Massive Multiplayer Online Role Games (MMORG). Both groups (teachers and students) filled out a satisfaction questionnaire after trying the system out during the term. The questions were quite similar to case study 1 and the results obtained are presented in Table 3.

Table 3. Results of the student and teacher satisfaction questionnaire on the Likert scale for the second case study.

	Students			Teachers		
	Did not answer the question (%)	Disagree or Strongly Disagree (%)	Agree or Strongly Agree (%)	Did not answer the question (%)	Disagree or Strongly Disagree (%)	Agree or Strongly Agree (%)
1. Using a **game** as a learning scenario enhances the motivation of the student	0	0	100	0	0	100
2. Using a **3D immersive virtual world** enhances the motivation of the student	0	14.29	85.71	0	25	75
3.Promoting **competition** among students and groups enhances the motivation of the student	7.14	21.43	71.43	0	12.5	87.5
4. Linking physically distinctive signs to the achievements of the student as a mechanism of **social recognition** enhances the motivation of the students	7.14	21.43	71.43	0	25	75

6. Discussion of the results

In the first case study the analysis of the evolution of dropout rates during the 2005-2009 periods shows that when a traditional approach was followed, the dropout rate average (rate of students that attended the final exam in comparison to the number of students enrolled in the course) ranged from 60% to 70%. In 2007-08, the first prototype (*Mundo Nucleo,* which used a 2D GUI instead of a 3D virtual world) was used by a group of 22 volunteers. While the control group maintained a similar dropout rate (65.79%), the experimental group reduced the dropout rate dramatically, to only 9.09%. These results might be influenced by the voluntary nature of the experiment, which may have attracted highly-motivated students, and/or by the small number of students enrolled in the module (only 60 students compared to 115 and 110 in the previous years). Nevertheless, in 2008-09 the use of the second prototype, *Mare*

Monstrum, was compulsory for all students and the dropout rate at the end of the course was around 16%. Although this rate is slightly higher than the previous year, it is still a great improvement.

Nevertheless, although cases 1 and 2 have shown the positive influence of the method on drop-out rates and on the number of students passing the final exam, it can still be argued that there are many factors that may have influenced the outcome, besides the new pedagogical approach. For instance, the teacher's attitude may have affected the results, as she might have been more enthusiastic with the new experiment setting. This being a subjective matter, it is impossible to offer quantitative measurements to counter-argue it, but still, we can provide some evidence. First of all, the same teacher has been in charge of the FP course over the last six years. She has been permanently worried and concerned about improving class dynamics, and tried out some other motivational techniques in previous years, such as plain PBL, without obtaining significant results. Also, over the years, she has participated in the official Spanish Innovative Programs for teaching and learning. Another possible hint about her enthusiasm for teaching is that she has always obtained excellent results in the students' annual evaluation, no matter what teaching strategy she has used.

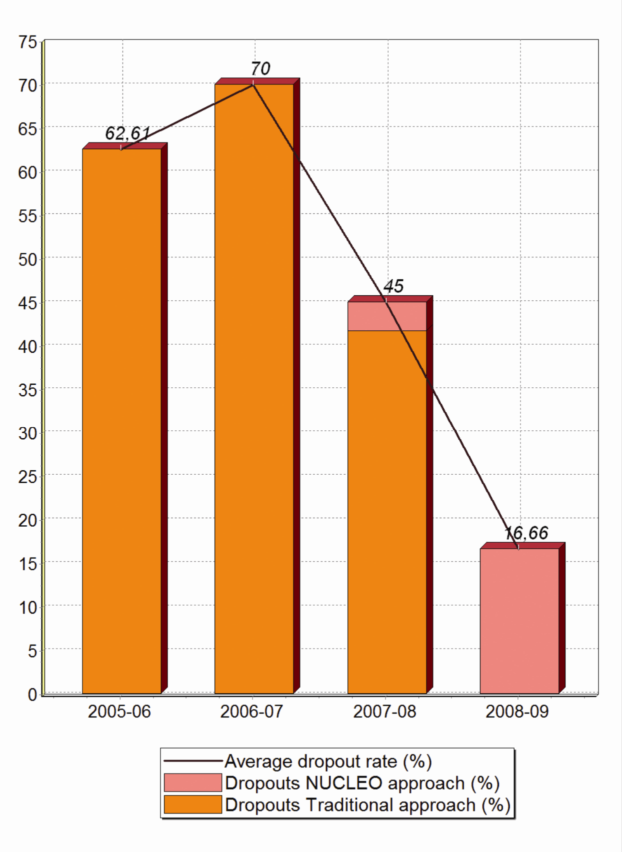

Figure 4. Evolution of the dropout rates over the 2005-2009 period. The chart shows the percentage of dropouts for control and example groups (traditional or *NUCLEO*) in each year and the evolution of the weighted average dropout rate of the whole group.

Even though these arguments can support our conclusions to a certain extent, no doubt an accurate validation of our conclusions would require wider experimentation. As Hays points out, demonstrating the efficacy of games in terms of acquiring knowledge would require the whole educational community to work together for many years [31]. Also Freitas in [21] highlights this issue as one of the most difficult to achieve for game-based learning applications. Although solving this problem is certainly beyond the reach of our possibilities, the NUCLEO project keeps on and more experiments are being performed to determine the validity of the methodology in the long term.

According to the satisfaction questionnaire after the first case study, 95.35% of the students thought that the role-game dynamics made the course more motivational. Regarding the use of a 3D virtual world as user interface to immerse the learning scenario in a fantasy world, only a slight majority (55.81%) considered that it was positive for motivation. Finally, boosting competition through social recognition strategies was motivating for only 65.12% of the students.

Several conclusions can be inferred from this data. The most relevant is that the most powerful aspect for motivation is the use of game mechanics and strategies in the learning experience, regardless of how the game is presented to the students (using a 3D virtual world interface or a 2D UI). Secondly, it is interesting that the competitive atmosphere does not seem to be important to a considerable number of students (around 35%) in terms of motivation, which suggests that this strategy is not adequate for all the students.

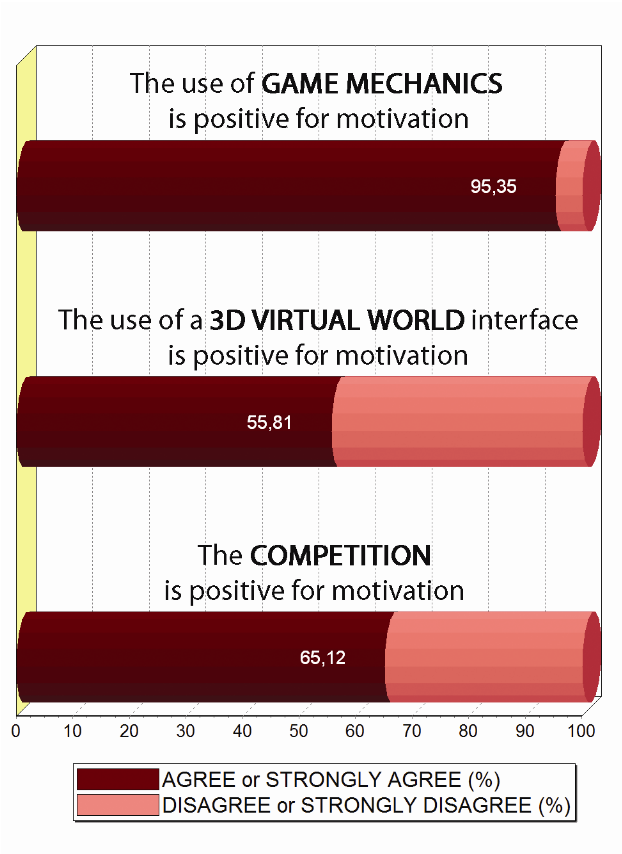

Figure 5. Results of the Likert student satisfaction survey for the first case study

In the second case study the results of the satisfaction survey (the only metric used) were separated into two different groups for analysis: teachers and students. The results of this survey suggest conclusions similar to the first case study. In this case all the students and teachers (100%) agreed on the potential of game mechanics to enhance student motivation. Regarding the competitive atmosphere the results are quite similar in both questionnaires (ranging from 60% to 70% approximately).

Nonetheless, there is a relevant difference concerning the ability of the 3D virtual world to engage students. In the second case study all the teachers (100%) agree that the 3D virtual world interface is positive for students' motivation, while the percentage of students that think the virtual world is a positive element in terms of motivation rises to 85.71%. This data is much higher than the 55.81% obtained in the first case study. This difference may be related to the fact that the students selected fro the second case study were frequent users of MMORGs.

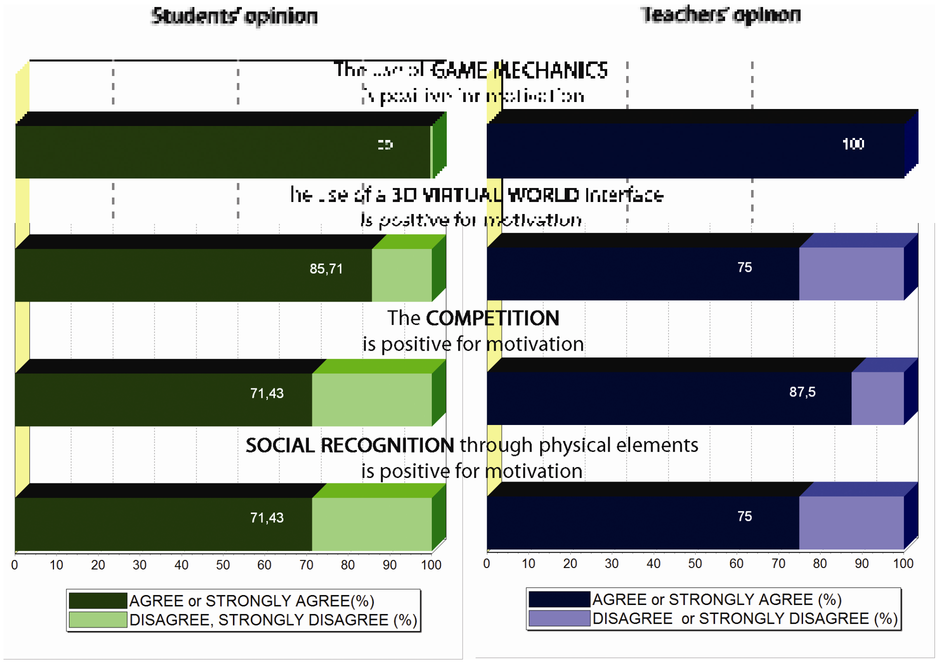

Figure 6. Results of the Likert satisfaction survey for the second case study.

7. Conclusions and future work

In this paper we have presented the results obtained in two case studies aimed at evaluating a set of hypotheses related to how three different strategies used in the *NUCLEO* framework affect student motivation. The evaluation was performed using two prototypes of *NUCLEO*: *Mundo Nucleo* and *Mare Monstrum,* which share the common ideas behind *NUCLEO*, differing only in the nature of the user interface: while *Mundo Nucleo* used a plain 2D interface, *Mare Monstrum* replaced this layer with a 3D immersive virtual world. This allowed us to analyze the effect that this specific feature (the application of a 3D virtual world as user interface) actually causes on the motivation of the students.

Even though this evaluation is just a starting point and more practical research has to be performed in order to infer further conclusions, taking the results obtained in our experiments as a base, we can extract the following conclusions:

- Multi User Virtual Environments can enhance student motivation if they are designed carefully, following a sound pedagogical approach.
- Fantasy and gaming are powerful motivators. But representing them through an immersive 3D multi-user virtual world interface, with powerful graphics,

does not seem to be as important as the gaming or the learning strategies themselves.

- Boosting competition by using social recognition strategies works very well for the majority of students while it is counterproductive for a considerable minority. While the causes of this unexpected issue are still uncertain, it is likely that students who do not have a competitive personality perceive this as extra pressure instead of additional motivation.

On the one hand, these are interesting conclusions for educational settings, where educational video games and MUVEs are sometimes rejected by using the arguments of high development costs and top-tier computers these systems usually require, or the complexity of getting these systems installed and running (not all instructors have the appropriate background to deal with this issue). In this concern the results suggest that to design highly motivational video games and MUVEs with educational value the investment does not necessarily have to be focused on the development of powerful technology (e.g. complex 3D graphics, sophisticated Artificial Intelligence, etc.) but on the good design of the underlying gaming and learning strategies. This allows us to avoid the most expensive or system-demanding approaches. Following these indications we could reduce the development costs of educational MUVEs, the complexity of the installation process and remove the requirement to have top-tier computers in the classroom, which would open the range of educational institutions that could adopt this kind of instructional approach. Additionally another interesting conclusion is that, in light of this data it might be necessary to redesign the competitive atmosphere or provide alternatives for those students who do not feel attracted by competition.

On the other hand, in spite of the fact that the case studies described had quite positive results, it is still unclear which part of the results come from the change in the class strategy itself and which comes from the use of the 3D virtual environment. Moreover, it would be necessary to analyze whether the enhancement of motivation that the results suggest is a real consequence of applying the *NUCLEO* pedagogical framework or just the by-product of introducing a novelty into the routine of daily learning dynamics. Nonetheless these results suggest that these immersive environments could be quite appealing for digital native students that are more technologically oriented or for those that are hardcore users of social networks.

Besides, the *NUCLEO* approach should be tested in other engineering environments in order to determine whether the conclusions extracted about the impact on students' motivation are scalable to other disciplines (e.g. product manufacturing, mechanical engineering, etc.). It would not be difficult to produce new instances of the general *NUCLEO* framework apart from the development cost of repurposing the prototypes (*Mundo Nucleo* and *Mare Monstrum*) or implementing new environments, as it is built upon solid educational principles that will fit almost any engineering course. For instance, the Problem-Based Learning approach and the role-playing strategy are easily scalable to other domains, as discussed in section 2. Besides, cooperative and competitive strategies are two desirable skills that all engineers should acquire. However, embedding an engineering course in the fantasy atmosphere that *NUCLEO* presents is challenging and demands a high level of imagination that not all instructors have.

Next steps in the project are to obtain a more complete MUVE, easier to install, with better teacher support, and to extend its usability to other knowledge domains different from programming courses. In addition, *NUCLEO* will also be applied this year (2009-2010) in a real engineering education scenario, which will add more data for analysis and further conclusions.

Acknowledgments

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Step-wise immersion bridging two universities

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Abstract. Media Design students from Moholy-Nagy University of Art and Design (MOME) and programming students from Eötvös Loránd University (ELTE) produce a braid supplementing each other to produce a productive workshop for urban games and museum applications. In order to experience technology and use it as a tool for collaboration OpenQwaq virtual world platform was chosen based on social learning theory and an environment was developed for step-wise immersion to experience and invoke creative ideas for innovative projects. The setup for design-based research is described in the paper.

Keywords. virtual worlds, interaction technologies, social media, mixed reality, augmented reality

Introduction

We are witnessing a constant development in the hardware and software environments making possible Augmented and Mixed Reality applications. Our own experiences teaching students with different background and interests in two universities (information technologies and media design) as well as international examples suggest that novel applications and experiences can be invented by bridging the two kinds of expertise and attitude. Our educational objective was to create an environment for students to be able to experience the necessities of new technologies everyday life, as a student, as a professional, and as a citizen enjoying learning experiences.

Moholy-Nagy University of Art and Design (MOME http://www.mome.hu/) is a small, traditional art and design university, with students excelling in visual design and creativity in different disciplines, including Media Design, Eötvös Loránd University (ELTE http://www.elte.hu/) is a big old general university, with several Faculties, including informatics. MOME's Creative Technology Lab and ELTE T@T lab has a strong motivation to join forces, due to the fact that the former's profile is media design while that of the later is media programming, thus the two produce a braid supplementing each other to produce creative edutainment and museum technologies. Students were enthusiastic to improve their environment, in musea and in town and some projects even raised the interest of musea. However, we encountered great difficulties in managing the co-operation and running the parallel projects with the two universities being in separate locations, time schedules of classes being different and communication being scarce between participants, due to technological issues [1].

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1. Common Project on Developing Serious Games

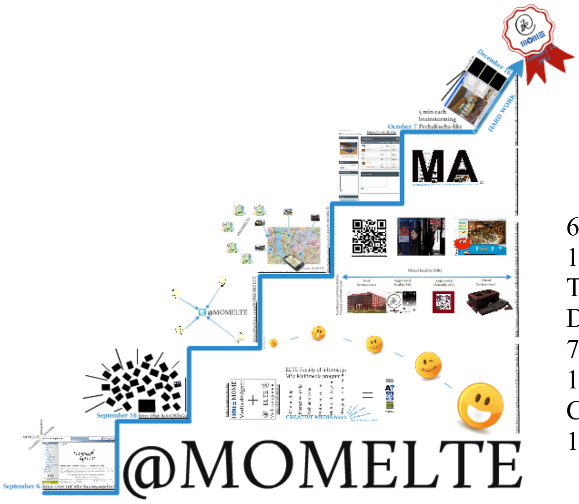
The MOMELTE project (co-operative project between MOME and ELTE universities) was launched to build Serious Games in form of a competition. The MOMELTE portal (http://tet.inf.elte.hu/momelte/) provides links to comprehensive descriptions of the project itself and the technology used. The announcements were sent out to all students' mailing lists in both universities as well as in form of Tweets to reach those already in connection to the organizers after partially completing previous courses. Some predefined courses at both universities composed their aims to take part in this project specifically, but any student from either universities, were welcomed to join in. Requirements for entering the competition were:

- The serious game should have connection to some form of formal or informal learning, indoors or outdoors of museum area or any other specified location, including virtual spaces, motivating the learners' involvement.
- At least one of the following three technologies has to be involved: multi-touch or other gestures, augmented reality, locative mobile technology.
- Work has to be done in groups, containing at least one student from MOME and at least one student from ELTE and a consultant from either university.
- Work steps have to be traceable within the built virtual collaborative platform.

Awards: Some awards for original works were offered by both universities and others were offered by industry as well as further awards are still under negotiation as the interest is being raised in several creative circles.

Background for work: At MOME the Creative Technology lab offered premises and technology for experimentation, while at ELTE T@T Lab offered premises, technology and equipped the large student area with various technologies to experience while enjoying leisure time. Both universities offered several courses, which would specifically help students with progress in achievements. MOME has a specific course in which common projects are built with specific museums, thus a critical number of museums are involved from the beginning, but others are also welcome to join.

Timing of real world events (Fig 1.):



6.9.2011 @MOMELTE launch
16.9.2011 Brainstorming
Tweeting project ideas
Displaying projects in Junaio
7.10.2011 Project presentations
16.12.2011 presenting results
Committee evaluates projects
14.1.2012 Award ceremony

Figure 1. Presentation of @MOMELTE project on Prezi:
http://prezi.com/fsvki5z7hg5x/momelte-projekt-step-wise-immersion/

2. Design considerations for choosing a collaborative platform

Probably the most difficult part of the co-operation is synchronizing communication and monitoring collaboration:

- Having different technological backgrounds and use of such tools, students need to be introduced to technology through their own experiences in order to raise attention to new developments and allow emergence of innovative ideas.
- Informatics students are highly disciplined and use different technologies for sharing files, but are less communicative. On the other hand, art students are more philosophical and refer mainly to Raison D'être.
- The timing of different courses cannot be synchronized, so real-time meeting are quite difficult to achieve.

We have already tried several approaches in using collaborative technology (Google Sites http://sites.google.com/, BSCW http://public.bscw.de/), but none were really working, especially due to our persistent requirement to log actions of collaboration in order to be able to monitor events from both sides, whether the projects are progressing in a good pace. Thus we had to dig deeper using design-based research in order to come up this an environment that works effectively in our case.

2.1. Virtual world platforms

Virtual worlds are quite commonly in use for educational purposes, especially for language education [2]. Several courses at ELTE University are exploring different platforms: *SecondLife* (http://secondlife.com/) (where students experience different approaches to virtual existence and educational potential, joining different existing Slurls to exploita practices), *Visuland* (http://visuland.com/, where students built their own situated learning environments and interactive presentations to exploit its educational potential), *OpenSim* (http://opensimulator.org/wiki/Main_Page, where students import their 3D models and built educational scenery for creating a constructivist learning environment involving development of interactives) as well as *Edusim* (http://edusim3d.com/,where students experiment production of 3D interactive for whiteboards), *Unity* (http://unity3d.com/, where students create 3D learning games) and *Flash* (http://www.adobe.com/products/flash/, where students create different education games).

Despite the fact that virtual worlds are often used effectively in education, in some cases there may be problems which can go to the expense of effective learning [3]. At the planning stage, one has to answer several questions in order to determine how much effort is necessary to put into the design process to come up with an efficient solution worth the effort?

It is well worth to look into the investigation of design effort to stage the particular collaboration vs. 3D added value affecting the quality of learning outcomes based on the classification of collaboration and learning pattern. One can well see the diversity of efficiency in learning outcomes for designing different types of collaborations through the mapping of patterns [4].

Our choice was on the Quick win design having 3D experience as natural solution with seamless patterns, where simple elements (different file types and video/slides) can be presented, users can have interaction with them and with each other and the 3D added value requires only low design efforts.

2.2. Using Social Learning Theory in making a choice

Smith and Berge analyzed [5] whether the three key components of Bandura's [6] social learning theory (observational learning, imitation, and behavior modeling) manifest within Second Life, being the most popular for use in higher education.

Newcomers always start with lurking, observing the behaviors of others' online, users can experience the tools that others have used, instructors can observe other instructors, and students can learn the acceptable behavior of other students. Though there are some rules that need to be stated, one can learn fair easily what can or cannot be done in-world by observing the behavior of others.

Imitation and behavior modeling – which comes after experiencing positive behavior at the first stage of observation – is one of the main features of SecondLife, as configuring and dressing up avatars is a basic element in-world, it is designed for role-play and there are plenty of sites and environments where different behaviors could be observed and imitated. Of course this could be a virtue on one side (encountering verity) and a flaw (picking up on the dark side) at the same time. Being a world of continuously inhabited terrain one can gain plentiful experiences and get distracted at the same time, not to mention the unfortunate possibility of becoming addicted. Once becoming expert in use and experiencing the Flow [7] performing in-world activities, learning and collaboration does not mean a burden to intentions. However, a learner as a newcomer needs to invest some time before managing the tasks that are required in the educational process.

However, an important concept of observation and modeling is directed towards attitudes and emotional reactions, which is an important factor in learning and collaboration. SecondLife, however does not manifest to this need, as emotions and reactions can only be transmitted using the built-in symbolism that can be controlled by the user, but that does not reflect true emotions. These features help expression in role play, but does not provide feed-back needed in human-to-human interactions, which are the natural virtues of communication in real world.

Our choice for OpenQwaq as collaborative environment for common project work was made according to the following analysis:

- SecondLife is very expensive to set-up, maintain and update with these resources needed to establish a sound pedagogic environment for the types of interactions required for the success of our project.
- OpenSim is much more cost effective in this respect, however it needs dedicated hardware, professional set-up, administration and maintenance, as well as designers and programmers to build resources in-world. Being in the Faculty of Informatics, seeking the proper hardware is not problematic and neither is administration of the complete set-up. Building resources in-world is an interesting activity that could also distract attention from the task of collaboration on specific projects. But, as a dedicated project, this could be a perfect theme for collaboration between students of media design and media programming. Thus we developed an environment for the specific creative project: *Build a common in-world campus with exhibition area*.
- OpenQwaq needs also hardware and set-up (much more than OpenSim, as it was released recently and does not have a robust developers' community as background support). The platform can also be used as a file server allowing collaborative work as on a custom portal or by entering the 3D world, getting immersed in the full environment, the same resources could be found and

‘touched’ for interactions (Figure 2.). One can develop as many rooms as needed per teams with just a matter of duplication, which could then be configured as needed for each group. It has most of the interactive features that the other two provides: text chat, voice over IP, teleporting, interactive panels, …etc. and soon video streaming will be integrated in the coming upgrade. Besides, the interactive features accessible on panels provide much higher level of interaction which is a virtue in collaboration. Although avatars cannot be configured the video signal can be projected onto the face area of the avatar (once video streaming is integrated), providing feedback on attitudes and emotional reactions, which is not possible in the above two worlds.

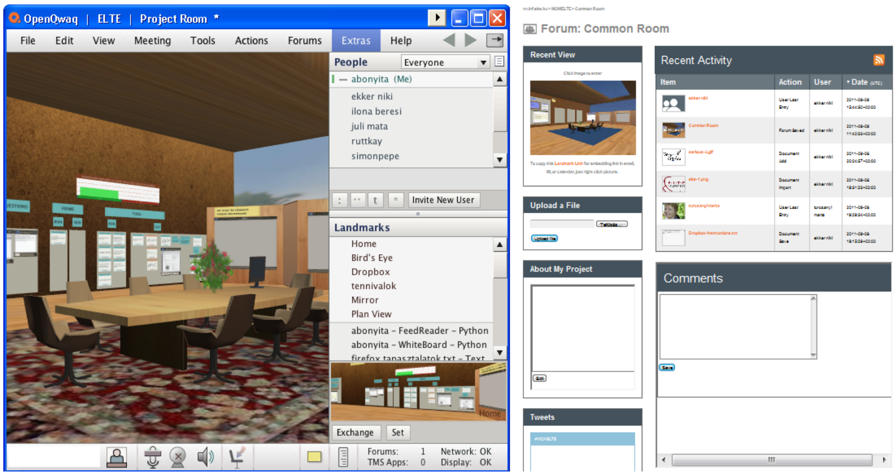


Figure 2. Open Qwaq – Common Room for MOMELTE project (left - 3D, right – portal form).

Unavailability of some features existing in the other two virtual world are virtues :

- Avatars cannot be fully configured, which was one of the most favorite activity for users in SecondLife, however this could be also a distraction when collaboration in the main issue and this extra task of creating new forms of avatars could be a separate project theme for 3D modeling classes taught at both universities.
- Building in-world is not possible (only pre-built items can be added), however this is a virtues, since students are not distracted in this direction.
- It is not open, so only those worlds can be visited for which one have authority to enter. This could hinder the Flow to emerge so quickly in users, however there is less to master since it is a more restricted world and one can concentrate more on the collaboration over the assigned task. The design of the working area can be built to allow some leisure time activities as well and an exhibition area, where the works of previous projects could be experienced and social processes invoked.

Thus, students used their own Learning Management Systems within their own university courses that they were already accustomed to and we set up an OpenQwaq platform for collaboration in MOMELTE project and for one specific project theme we set up an OpenSim server to allow development of a virtual campus for the future.

3. Introducing Step-wise immersion for MOMELTE project

We have devised a new methodology for immersing our students into mixed realities step-wise, by experiencing technology and museum environments, being precise and concise, respecting deadlines, getting to know collaborative technologies, developing an inventory of common vocabulary for discussions, being able to find own added values to supplement each other in projects, documenting feedbacks and steps taken, getting more and more immersed in virtual reality by shifting collaboration towards this area and developing experiences that could lead to innovation of ideas well useable context of musea [8]. Thus the user experience during an emerging co-operation could lead to innovative design ideas and technological awareness in choosing proper tools to accomplish goals. The same applies to musea, which are the least aware of the demanding changes of time and are reluctant to ask for help from both sides, but are uneasy at becoming technology users. Nevertheless, we left the developed Google Sites area as an alternative workspace for those finding it difficult to use the newly developed environment with more immersive features. These project participants are provided with basic, less advanced collaborative tools: area for definition of project and access to participants, file area (to exchange project files), memo area (to document meetings and agreements), discussion area (for asynchronous conversation).

3.1. Step-wise immersion – the steps to be taken

1. Take part in the introductory event on September 16th.
2. Read incoming project ideas in form of Tweets coming into @MOMELTE and the web page blog for news on the project and checking out the calendar.
3. Composing project ideas, saving it in PDF and uploading it into a public area.
4. Sending out a Tweet with own project idea including: name of the project, Keyhole Markup Language (KML) positioning in town, link of a relevant picture and link of the PDF file introducing the project. Profile of user should illustrate his/her background!
5. Venues of the project ideas could be located in two ways: if one has smart phone, then launching *Junaio* (http://www.junaio.com/)application and allocating MOMELTE channel, or if one has access only to desktop applications, then the Junaio developer page allows the search for channels and shows all Points Of Interests (POI) after searching for e.g. Budapest.
6. Search for partners by Tweeting using #MOMELTE as hashtag.
7. Choose consultant from either MOME or ELTE.
8. Attend the *PechaKucha (http://www.pecha-kucha.org/)*–like project introduction event, introducing the group and the project itself.
9. Ask for an account on VV (Virtual World) file server.
10. Ask for a group Forum on VV for co-operation.

3.2. Steps-wise immersion – the user experience

1. It is important for all participants to get to know the project in details and be able to identify major participants to make contact in real life. The event is recorded, so it could be streamed any time for those, who could not attend. Real connections and visual illustrations are of high importance at the start of any project, with encouragement of direct communication between partners.

2. Twitter is being introduced on a reader level, to experience how ideas could be published and read instantly using this technology. The need and relevance of concise messages could also be experienced here. Raising the attention of students to project ideas could soon lead to willingness in participation, which needs registration on Twitter to be able to send own ideas and feedback.
3. Students are already used to submitting work in PDF-s, however they have to make sure that they are placing it into a publicly available storage area, which can provide an accessible link to anyone.
4. Sending out concise messages is of crucial importance, thus great discipline is needed at this point. A well defined profile should illustrate the institutional background and profile of the user. A detailed description is provided on using Twitter and helping to produce the required shortened links of picture and PDFs as well as allocation of KML for positioning. This provides a good background for several locative technologies. Students or consultants form either universities and well as musea contacts can all initiate emerging projects this way and get to master the technology as well.
5. Locative technology could also be mastered at a next level using smart phones and Junaio technology. This could facilitate participants to search for the proposed venues and examine the environment where the specific projects are to be launched to provide adequate background knowledge for the aims. But, if someone does not have a smart phone, the Junaio developers' web page also allows the access for the same information online, it just needs a separate step to go out and check the location on spot.
6. Tweeting in search for partners needs a more immersed practice in this technology, providing a form of immediate communication in project work.
7. Choosing a consultant is for practical reasons, making sure that everyone will have a helper and could get credit for project work. Besides, this also forces the university staff to get immersed themselves ☺
8. The Pecha-Kucha-like event provides all project groups to introduce themselves in 5 minutes each and gives ground to feedback and encouragement as well as orientation or attraction of further partners.
9. VV file server works as a general web-based collaborative file sharing and discussion area, where one can find: the short project description with access to participants and links to the most important files of the project, group Tweets that contain the #groupname hashtags, file uploading/downloading for memos and project materials, and a discussion area. (This basically has the same structure as the alternative working area on Google Sites portal.) Musea currators would most probably use this level for contact throughout the project, but might be motivated (if brave enough) to go further one step.
10. The VV environment provides a visually appealing 3D immersive space (Fig 3.) in which one can recognize the above (No 9.) elements situated in the left side/corner, where all the Tweets, project descriptions could also be found and high levels of interaction is allowed on these objects as well as Voice over IP (VOIP) and soon video streaming. Students can share their emerging work online, while their collaboration can be monitored from either side. Students are obliged to take at least one action per week to show their progress, either online in VV world or in form of Tweets, piped in-world. Student collaboration requires discipline as all objects scattered shall be removed and only those that are placed on shelves would be backed up on a daily bases.

Figure 3. Open Qwaq – project room tempate.

3.3. Development of the step-wise immersive environment

Google Sites (http://sites.google.com/): provides informative web pages with a counter indicating the number of days left till the final deadline.
Twitter (http://twitter.com/): provides immediate communication of disciplined content which can be filtered and piped into further applications as RSS feed .
File stores: Google docs (http://docs.google.com), Microsoft Live (https://login.live.com/), Drop-box (http://www.dropbox.com/), or any other services on campus could be used to upload PDF files.
KML (http://hu.wikipedia.org/wiki/Keyhole_Markup_Language): Google Maps (http://maps.google.com/) or Bing Maps (http://www.bing.com/maps/), Wikipedia, Twitter's own place locator or other services to obtain KML positioning of an institute.
Picture: Flickr (http://www.flickr.com/), Twitter's own predefined services, or any other service could be used to upload pictures taken.
Short links: Bit.ly (https://bitly.com/) or Twitter's own service to shorten URL-s.
Junaio (http://www.junaio.com/): is a free application for iPhone and Android that are the most popular smart phones used in Hungary. The developer account allows creation of channels, where a locally hosted Apache server (http://www.apache.org/) or *Hoppala* (http://augmentation.hoppala.eu/) free service can host POI-s submitted. Tweets of required data are piped into the pre-defined POI structures. Junaio dev. page (http://dev.junaio.com/map/index/channel/95028/latitude/47.161160/longitude/19.504960/stream/false) allows an overall view of all POIs on desktop and on smart phones.
VV file server (http://vv.inf.elte.hu/): is actually the web access of an *OpenQwaq* (http://code.google.com/p/openqwaq/) server that has been installed for this project. All project groups are provided with a subdirectory using their project names and we have developed and extension for this access to accommodate a project description, Tweet gadget and Forum for discussion (on group level and individual files) using iFrames.
VV Virtual World: is the 3D immersive OpenQwaq access for collaborative workspace. We have created a Common Area for project participants to gather and brainstorm. All incoming project ideas are piped in-world and land on the Brainstorming wall, Tweets are piped on a communication board and Topic cards provide brainstorming and feedback as well as sticky notes allow spontaneous reactions. Text chat and VOIP is provides and soon video streaming is also facilitated. Several working areas provide interactive boards to share presentations, program codes and documents that could be edited online collaboratively. There is also a Gallery for social activities displaying products of former projects. Each project group is provided with a separate room for collaboration, including a communication board with group tweets being piped in-world, white boards and all the above interactive collaboration functionality that is also available in the Common Area. Each project room also has outdoors for leisure activities. The rooms are built to illustrate a comfortable working environment, but

students are encouraged to change and create new artifacts to increase their own comforts. We have also prepared user guides in Hungarian language to help users.

Automating this process is currently being implemented, so at present only semi-automation provides data piping and our own Apache server hosting POI-s is also under development, to be ready after this first project development process is fulfilled and we have adequate experiences to be able to fine-tune needs and aims.

4. Planned research

Design-based research assumes that context affects learning, offering a methodological tool kit to systematically and iteratively test and improve a designed learning environment and to generate theory alongside [9]. Considering the characteristics and affordances of virtual worlds, an adaptation was proposed to be used for virtual world research projects [10], iterating cycles of implementations-findings-implementations, in our case asking research questions:

- How much previous knowledge do users have about the used technology?
- How is the users' level of engagement during collaboration?
- How do users solve the project-related activities they assigned themselves?
- How is the users' motivation during collaboration?
- How do the consultant-student interactions affect the collaborative process?
- How do the students-student interactions affect the collaborative process?
- How were the collaborative activities performed?
- How is the social process emerging within the virtual world?
- What are the different social roles that users take during activities?
- How do the virtual world resources (physical, instructional, interaction based, etc.) scaffold learning and collaboration?
- How has the virtual world diffused to other consultants and musea personal?

Activities of participants shall be monitored on several levels: log files within OpenQwaq shall be analyzed using data-mining and similar analysis is needed on the web access of the portal platform (as activities within the same area can be pursued from either platform). Google Analytics shall be used with individual variables to investigate users' activities. After the end of the project, users shall fill out a questionnaire, which contain open and closed questions (using a 5 level Likert scale) about their collaborative impressions in mixed environment. We intend to make improvements to our mixed environment after analyzing feedback and monitoring data.

We presume that our first experiences will arise after fighting ourselves through the first process of experiencing this design-based research procedure. We shall evaluate the efficacy of our collaborative environment using the Four Dimensional Framework (Learner specifics, Pedagogy, Representation, Context) [11] and analyze findings in comparison to those found in similar set-ups using SecondLife [12].

5. Conclusion

By bringing together students of different background and exploiting the artistic, creative approach and the professional ICT knowledge and skills, novel applications come to life, as well as a new way of learning is demonstrated.

We made careful considerations in choosing a virtual world framework and additional technology was implemented to produce an environment where step-wise immersion could be attained in mixed reality. OpenQwaq technology has been released only this May, so there is just an emerging community of developers, apart from the fact that its origin, *TelePlace* (http://www.teleplace.com/) service has been around for some time. We have set up a research experiment to gather knowledge on the attitudes of students in both universities towards various forms of technology based collaboration, how their experiences influence the emerging projects, which are the more preferred steps and which ones need to be refined, how best could students be immersed into virtual worlds as a platform for collaboration as well as a platform for developing innovative ideas in musea context. Furthermore, we are also interested to see the emerging appetite of musea towards mixed reality use and developments.

We are ourselves looking forward to find out how this set-up would work out for us in augmenting experiences and bridging the two universities through mixed reality

Acknowledgement

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Unleashing the Power of Immersive Education Across a Global Fabric of Advanced R&E Networks

James Werle
Director, Internet2 K20 Initiative

Abstract: Immersive education applications are changing the way we experience information, learn, and socialize in the 21st century. These applications often demand higher performing networking environments than are available on the commodity Internet. Internet2 and the global fabric of not-for-profit R&E networks are purpose built to deliver the high performance, speed, and advanced services that allow these applications to thrive. This session proposes to introduce this global R&E community and explore the tremendous synergies and potential collaborations between Internet2 and the Immersive Education Initiative.

Formed in 1996, Internet2 is a not-for-profit advanced network consortium led by the U.S. research and higher education community. Its goals are to provide leading-edge network capabilities and to facilitate the development, deployment, and use of revolutionary Internet technologies. Starting with 34 universities, Internet2 has grown to more than 300 members, including more than 200 U.S. universities working in cooperation with 70 leading corporations, 45 government agencies, laboratories, and other research institutions.

It took nearly 25 years for the Internet to diffuse beyond the research community into the educational mainstream. Leaders in the U.S. academic research and technology community saw an opportunity with Internet2 to engage the broader education community in the development of the next-generation Internet much closer to “launch.” By putting tomorrow’s technologies into the hands of as many innovators and educational sectors as quickly and as “connectedly” as possible, the Internet2 consortium’s goal is to giveeveryone across the .edu spectrum the opportunity to shape the content, services, and applications of the next-generation Internet.

Toward that end, the Internet2 consortium launched the Internet2 K20 Initiative in 2001 to extend advanced networking access to K-12 schools, public libraries, baccalaureate colleges and universities, community colleges, and a host of cultural organizations such as museums, science centers, zoos, aquariums, and performing arts centers. Today, more than 65,000 K-20 organizations (K-12 schools, public libraries, etc.) are connected to the Internet2 network across 40 state and regional research and education networks.

Internet2 Connectivity Data

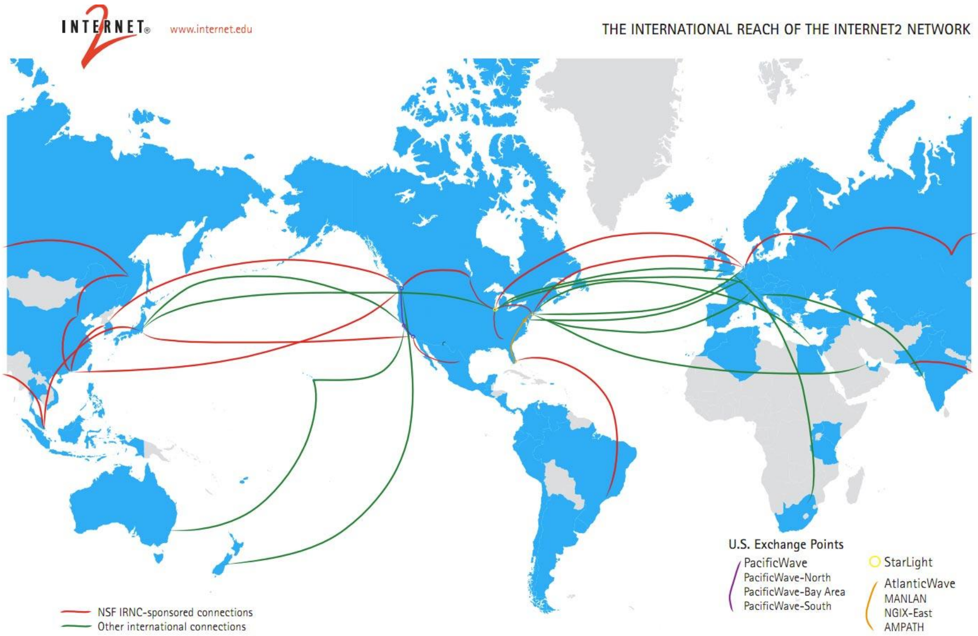
Estimated number of Educational Organizations Connected to Internet2 via the Internet2 K20 Initiative (as of 2009)

	Number Connected
K–12 Schools	52,836
Public Libraries	3,505
Four-Year Colleges & Universities	775
Community Colleges	648
Museums, Historical & Cultural Centers	78
Public Radio, Television & Streaming Media	32
Science Centers, Planetariums & Observatories	27
Performing Arts Centers	12
Zoos & Aquariums	14
TOTAL	**65,476**

Source: Internet2 K20 Initiative Connectivity Survey

Internet2 also peers with over 80 international advanced R&E networks all around the world – including 40 networks in Europe[1].

[1] For a complete list see http://www.internet2.edu/pubs/ReachableNetworks.pdf



Therefore, in essence, what has been created is a global, noncommercial fabric of interconnected advanced research and education networks enabling unprecedented levels of collaboration across all education sectors, both within the U.S. and around the world.Now that we have this tremendous infrastructure that ties global learning communities together more tightly than ever before, the question becomes how do we maximize its potential to support discovery, learning, and understanding?

The regular (or "commodity") Internet was not designed to handle the huge amount of data transfer, the explosive numbers of users, or the interactive, media-rich applications commonly used today. For applications where reliability is critical and delay is unacceptable—such as with real-time streaming events, access to remote instrumentation, high-definition videoconferencing, online gaming, and interactive immersive worlds and simulations—the commodity Internet is inadequate. R&E networks like the Internet2 network were purpose-built by the research and education community to offer the high performance, speed, and advanced services that allow these applications to thrive.

With fewer users and a backbone made entirely of fiber-optic cables, this global fabric of R&E networks is capable of moving data thousands of times faster with more consistent levels of performance than the commodity Internet. For example, it would take about 3 seconds to download a DVD-quality movie on the 100-Gbps Internet2 backbone as opposed to 6.5 hours with a T-1 connection and 25 hours on a DSL or cable modem. Access to advanced R&E networks like Internet2 allows educators to think beyond the current limitations imposed by the commodity Internet and enables students to experience the unthrottled power of immersive education tools operating at their full potential over the network.

Finally, for all of its ability to move bits and bytes around at the speed of light, what makes Internet2 and other R&E networks transformative is not just the physical network, but the network of innovators it helps enables.The iED summit in Madrid is an ideal opportunity to introduce Internet2 and the K20 Initiative to the iED's community of experts in the development and use ofvirtual worlds, learning games, virtual laboratories, educational simulations, and augmented realityand to explore the tremendous synergies and potential collaborations that exist between our two efforts.

Posters and Demos

How to involve Serious Games in traditional learning processes

Mr. Jon Arambarri – R&D Manager at www.virtualware.es
Mr. David Moreno Canta – Education Manager at www.virtualware.es

Abstract:
Serious Games have emerged as a new tool to assist traditional learning program. In these environments, the student is immersed in the learning process (learning by doing), experiences multimodal sensations and interacts with virtual objects including other humans.
In-vitro virtual laboratory is oriented to enhance the learning process of the scientific method in the laboratory. In-Vitro takes learners through the complexity of a chemical process, activating and feeding curiosity and reasoning, and supports the creative applications of the theory. It enables online interactive experimentations by accessing and controlling virtual instruments, or using simulated solutions. It also mediates the complexities of creation and usability of experiments, for specific pedagogical contexts in primary and secondary schools and higher education, including at university level

Serious Games

Compared with standard training representation of full chemical procedures, Serious Games can bring value-added components and material accuracy to facilitate practice on rare cases (even, they allow performing high danger tests with no risk for students). Serious Games also bring an opportunity to change more radically the paradigm of technical skills training as they bring with them automation, precise monitoring, full recording of real-time quantitative data and immediate feedback; new features that were hardly available before. VR technologies offer the opportunity to reconsider didactic learning processes with new eyes.

In order to stimulate motivation and engagement of individual students and class groups, a virtual learning environment has been created that is:

- Learner-centric
- Highly individualized
- Aimed at encouraging exploration of laboratory contents

IN-VITRO – Virtual Laboratory Demo

In-vitro virtual laboratory aims at enhancing students' knowledge in science. Although this project is done for the first cycle of secondary education, the same concepts can the applied for making chemistry works at a higher level.

In- Vitro Virtual laboratory is an **interactive 3D application** for discovering the scientific method, and how to use the laboratory following the most basics hygienic and safety rules, where the materials can be found through the game, the different compounds studied. At the time, the student plays with all the maters available at the virtual labs with no risk at all.

During the virtual activity, students understand that they are surrounded by chemicals materials (even matters hidden in a pond) or through the use of magnifying glasses the composition of minerals. Microscopes, magnifying glasses, matters and more stuff, allow users to perform virtual chemical experiments. At the same time the learners work on these tests, they get conscious of the effects of these activities in time, waste, energy, water, biodiversity and get environmental and sustainable development management skills.

In Vitro follows a **collaborative learning methodology** allowing users to learn both in groups or individually, both at home or at school on their own pace.

In addition to the direct knowledge in chemistry obtained, this serious game helps to developing cross disciplinary skills. This innovative approach life sciences and the critical information obtained, puts into practice the knowledge students got in the traditional learning process and developing new collaborative working skills. As a consequence of this training program students achieve a positive attitude though different motivating factors.

The educational videogame is divided in 5 different missions that the students have to resolve. They will get grade if they are solving the different laboratory activities included in each mission.

The project has been developed in Adobe® Flash® Player 11, a cross-platform, browser-based application runtime that provides uncompromised viewing of expressive applications, content, and videos across browsers and operating systems. Adobe has been the technology selected, because it is an industry-standard and with the aim of promoting the easy adoption by users. This application has been developed to be easily adapted to other platforms and devices, such tablets, smartphones (android and iphone).

Video URL: http://www.youtube.com/watch?v=5Dv96bBvV5Q

Conclusion

Educational games are a rapidly growing industry especially in education, already enjoying the positive effects that serious game implementations covering learning needs. This serious games has been created to provide the most engaging and effective learning experience.

3DTrends –Transferring Pedagogical User Experiences in Virtual Environments

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Coordinator of Finnish Learning Environment Projects (National Board of Education)
Oulu University of Applied Sciences Finland

Finland Finland is known for its expertise in technology, product development and innovations

Finnish schools can be seen as pioneers in introducing new learning environments and developing those within the institutions. These learning environments have been piloted with advanced technology; Finns has been among the first ones to enter for example Second Life not to mention Finnish innovations such as RealXtend virtual worlds.

As exploring new worlds in advanced technology context, it can be easily forgotten to learn from the past as you reach for the future. Pedagogical models in 3D virtual environments are not inventions of today although in discussions it seems like we still do not even have one. Instead of continuing search, pedagogic models and user experiences can be utilised and transferred into new advanced environments.

3rd Dimension is Real in Vocational Education

This demonstration presents Finnish models from immersive 3 D environments; best practices, pedagogical models, innovative learning environments and creative approaches when utilizing immersive technologies in education. The demonstration describes how vocational teacher's role developes in the renewal of the information society as we enter the 3rd dimension.
Defining collaborative learning environments is challenging and rewarding. Different solutions support multi-disciplinary and interprofessional collaboration in learning as far as to support active citizenship in information society.
This demonstration shows the path from testing multiple pedagogical approaches in virtual worlds such as Secong Life into the future of learning in learning environments like RealXtend. These new environments combine the personalized learning environment into collaborative new space of engaging learning and gaming as far as offering challenging learning experiences as edupreneurship in virtual world.
In the demonstration will be seen examples by following themes:

1) The Beginning – Exploring Second Life
   - Learning can be fun – together
   - First educational steps in virtual worlds

- Teachers as learners

2) Learning in Different Spaces
   - As Second Life evolves, it brakes the walls of the classroom
   - Teachers as architects
3) Learning in Space
   - New virtual learning environments combine different needs of teachers, students and even administration and marketing
   - Live roleplaying games: you do not need to own land to collaborate or share experiences
   - EduPreneurship in SL
4) Building a House – by Gaming?
   - Transferring experience into new environments
   - RealXtend as Gaming platform
   - Challenge of distribution

Demonstration panel will state similar to presentation http://www.slideshare.net/slahdenp/i-ed

Collaborative Connectivism

Studying a profession is based on skills needed in working life and terms of life long learning. Experts of the future are expected manage overall processes, have excellent problem-solving skills and ability for maintain and continuous renewal of their professional skills in professional networks. The pedagogical methodology dates back to connectivism and is based on collaboration. Co-operation with business partners facilitates work life oriented pedagogical development and educational technology transfer. User experiences from Second Life environment and similar solutions, show how student centered learning strategies with work life oriented assessments and cooperation can promote learning and knowledge-based networks. These practices may even prevent intermittence and dropping out of studies. These solutions create a personal learning path towards the new, digital world of learning.

Technology Transfer and Training

Engaging students and competence building for individuals and teams can happen in various learning environments, which can be physical and virtual – today even enriched, ubiquitous and mobile. Technology, of itself, cannot drive the educational change. This raises a question, how transfer user experiences in virtual environments to support learning in different contexts, environments and by utilizing appropriate technologies. How to share and deepen knowledge of immersive education? How people want to learn and how the information and skills what they need to learn is taught, shared and delivered in 3 D worlds following pedagogical trends and learning from the experience? How do these technologies promote collaboration and networking between different organizations and educational institutions nationally and internationally?

The 4th dimension?

Technology, of itself, cannot drive the educational change. The pressure for change is particularly directed at the role of teachers (teaching in general develops towards guidance and support), leadership and educational support services as well as updating training and learning environment solutions. How can we identify real-time and accurate information and make the shift from "just in case" towards "just in time" – training. What kind of education technology – tools, virtual learning environments, social media and mobile solutions - can be used to foster engaging learning as an entity of enriched learning path?

Virtual 3D Environment for an Internet-Accessible Physics Lab

Consuelo Fernández[a,1], Teresa Martín[a], Ana Serrano[a], Federico Prieto[b] and Ricardo Burgos[a]
[a] *Universidad Politécnica de Madrid*
[b] *Universidad Carlos III*

Abstract. In this work we present a virtual 3D Physics Lab which is part of a project financed by the Polytechnical University of Madrid (UPM) within its innovative educational program. The aim of the project, called Experimental Platform for Engineering and Architecture Studies of the UPM (PEIA-UPM), is to group the different experimental initiatives related to the tele-education inside UPM and manage them from a virtual 3D world similar to "Second Life". In this project you can see the Virtual Physics Laboratory which has been completely developed in a 3D virtual environment. We have chosen a modular design, grouping the activities related to a determined physical concept in the learning modules. Each module is composed by theoretical, practical, and self-evaluation activities. This way, the student, with his avatar, walks through the different aspects that will let him understand the concept which is being developed. This organization of the material allows an orderly growth of the lab by the incorporation of new learning modules. With the purpose of demonstrating the possibilities of the platform as a first practice, we have chosen the gyroscopic effect. In it the student can access the theoretical concepts, view the functioning of a real gyroscope, manipulate different tops or direct the flight of a helicopter. It is important to point out that during each one of these activities there are different self-evaluation quizzes with different formats and levels of difficulty.

Keywords. Virtual Lab, Physics Lab, SecondLife, Opensim

Introduction

It is a fact that educational systems in general and higher education in particular are living in times of change. So, in the new European Higher Education Area (EHEA) a competency-based training, focused on independent learning of students, was introduced. This new framework forced the reconsideration of the contents and the way we teach and learn; in short, the way to manage knowledge [1].

In this sense, new technologies are a great opportunity because they allow us to interact with knowledge in a more open, flexible and friendly way. In this context, the purpose of the work that we present is to offer to students an attractive material which encourages the approach to the complex physical concepts autonomously and creatively.

[1] Corresponding Author.

1. Project description

The Physics Laboratory is hosted in the Experimental Platform of Virtual Laboratories of the UPM (UPM-PEIA) [2]. Last year, several activities were developed in coordination with the different laboratories that are part of it. The platform is currently in beta version while being tested with the students.

This is a laboratory completely designed in a 3D virtual environment, in which the students use an avatar (which they have previously created, as in Second Life) to explore the virtual world and to carry out the proposed activities.

Each activity constitutes a *learning module*. The first developed module is about the *gyroscopic effect,* because it is a complex concept that allows to demonstrate the potential and functionalities of the platform by incorporating activities unthinkable in the real world. Thus, within the virtual "scene", the student will make a tour of the module's different elements. There is a first room with a virtual screen where they can watch a video with the basic theoretical concepts that explain the motion of a gyroscope. He can also watch a video about the operation of a real gyroscope laboratory. After, he goes to a new room where there are several tops with different geometry on which he can represent and manipulate the different parameters that affect their movement. Pressing a number of buttons the student chooses which variables he wants to view, launch the top and observe the movement, the magnitude and direction's change in the vectors. Finally, using the principles of the gyroscopic effect, the student have to learn how to drive a helicopter which describes certain routes previously established by us or by themselves, allowing future competitions among students. During each of these activities there are self-assessment questionnaires with different format and level of difficulty.

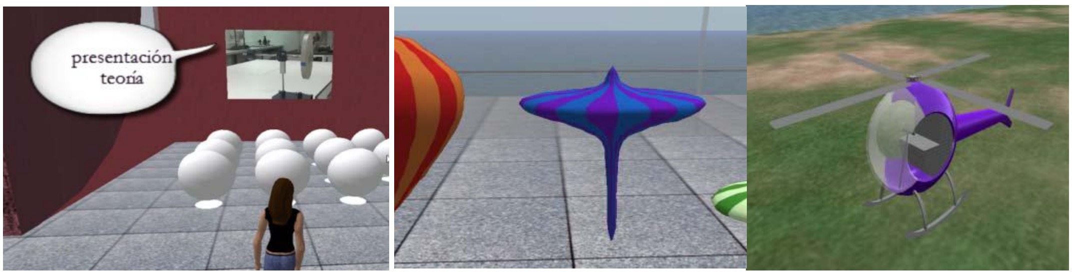

Figure 1. Laboratorio virtual de Física (PEIAE-UPM) http://youtu.be/9Yao15PfGDI

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Immersive Communication and Education

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Abstract. Immersive Communication and Education is the title of the last monographic issue published by ICONO 14, Media and New Technologies journal, together with the research group Socmedia (Universidad Complutense de Madrid) and the research group Ciberimaginario (Universidad Rey Juan Carlos). The journal, whose objective is to show a reflexive environment and scientific spreading about Media and especially on the Information and Media techniques, getting for this monographic issue the contribution from different fields of knowledge about the creation of new media and educational spaces based upon 3D, with the aim of getting in depth on the usage potentialities of these environments.

Keywords. E-Learning, Immersive Education, Immersive Media, Edumedia, Metaverses.

Introduction

Immersive Communication and Education is the monographic issue produced by the journal ICONO14 together with the research group Socmedia (Universidad Complutense de Madrid)] and the research group Ciberimaginario (Universidad Rey Juan Carlos).

This issue gathers the contribution from specialists from different fields on the creation of new Media and educational spaces in 3D environments. Methodological, experimental and reflexive contribution on the virtual worlds builders of pseudo realities, which and thanks to the presence feeling, interacts with the interaction with the environment and the sensorial feedback, facilitates the users' immersion. New contexts and new methodologies, which find their expression framework in an environment which goes into greater detail on the subjectivity of the didactic communicative act, at the same time that it take the knowledge closer to everybody, favouring the participation and cooperative work, above all the spatial inaccessibility.

So it is a selection of articles with which the aim is to analyse in depth in the usage potentialities of these new spaces of communication which transform and condition, in a great way, the ways and methods of social interrelation in the framework of the Society of the Knowledge.

1. ICONO14, Media and New Technologies Journal

Figure 1. Communication and Immersive Education.
Source: www.icono14.net

ICONO14 is a scientific publication coming out every six months, with issue for blinds, which is being published digitally since 2003, and from 2009 on paper [1].

Its aim is to offer a reflexive environment and spreading of different scientific work whose central themes go around basic research or applied contents, experimental, epistemological or descriptive on media and its sphere, and very specially, on Information Technologies and applied media to several fields of the knowledge under a communicative perspective.

The journal is edited by the Scientific Research on new Media Technologies, ICONO14, a non profit association funded in 2001 by researches from different public and private universities, interested in theorising, researching and shaping expression of topics and problems such as aesthetics, image, media and information.

One of the main objectives of ICONO14 is to build signals which may guide the complex social network and its components, on the course and the vital experience of the visual and audiovisual phenomena that they go through. A reference and thought group whose tool is the imagination and the specific epistemology to confront artistic, social, human and communicative problems. Scientific methods and fundaments are done specifically to attend the research with a non rhetorical rigor.

Figure 2. ICONO14. Source: www.icono14.net

The Journal ICONO14 is nowadays indexed in different directories, journal evaluation systems, bibliographic database and journal networks, and it keeps on working to improve its quality and relevance indexes. In the last year it has implemented the platform OJS

In its comprise to spread the scientific research on visual and auditory image, in order to promote the debate, the study of the most different aspects of image, of the contents, on the formats, on the traditional format, and the ICT, on the ways, genres and formats, on the audiences and the effect on them, has extended its knowledge field with new initiatives of scientific spreading such as the acts publication (with the support of OCS) and monographs, in both cases with an arbitrary system.

ICONO14 provides immediate free access to its contents under the principle that making the research available and free to the public will provide a bigger exchange on global knowledge.

ICONO14 adheres the different initiatives promoting the access to free knowledge, therefore, all the contents of ICONO14 are free to access, and costless, and they are published under the Creative-Commons license, type Renowned- Non commercial- No derived work.

Regarding its contents, the Journal is organised around a theme per issue and account, and besides it has an open section, interviews and recessions. Its monographic issues, coordinated by specialists from different universities from Spain and abroad, are oriented towards the analysis of great relevance topics with a scientific interest in the field of Media: Icons, Creativity, Internet, Videogames, Education and ICT, Radio and TV, theatre, protocol, Digital natives, Social Advertising, Media an EEES, Interactivity, Institutional and company-customer communication, Media and Society, Women and Technology, Media and Immersive Education…

2 ICONO14 JOURNAL. Year 9. Vol 2. Communication and Immersive Education

1. Context of the Publication

One of the most relevant features of the immersive digital spaces is the wide range of possibilities that they offer to the users as to create parallel actions to the real life. Even more, they are able to unite certain conditions and external factors with the insights of the human thought and what lies underneath the individual subconscious. This generic definition takes us closer to a concept which embraces ideal environments as to search new spaces, innovative experiences and extraordinary situations.

In a context full of initiatives dealing with finding new educational horizons, media, and at the end, the structure of the individual thought in the digital society is presented to us in a diverse methodology, with a new expression framework, free from spatial inaccessibility. As Janet H. Murray said (1997, page 109) [2], "our brain is prepared to dive in the sto ries with such an intensity that the world around us disappears".

This distortion of the surrounding reality can be also well-spent to get in depth in the knowledge fortress and on the concentration of those who start the didactic-communicative act. Immersion, and its ability to abstract the thought, become solid tools to induce the teaching-learning processes, at the same time that generate virtual materials with own meaning, inviting to the individual to communicate with its equal.

In this context, ICONO14 has had for the production of this monographic issue the collaboration of two groups of researchers, whose members have had a long researching history in the field of the Information and Communication Technologies. On one hand, the research groupo **Socmedia** (Universidad Complutense de Madrid) [www.gruposocmedia.es] who focuses its research since 2006 on the study of behaviours and socio-communicative learning competences and the leisure of children and teenagers (digital natives) through the mediation and the use of the new Information and Communicative Technologies and communication [3], and on the other hand, the research group **Ciberimaginario** (Universidad Rey Juan Carlos) [www.ciberimaginario.es] which works on different projects and initiatives on Interactive and Immersive Education and Media, and the educommunicative possibilities of the 3D environment (Gertrudis, Álvarez & Gértrudix, 2011)[4].The monographic issue collects from different fields of knowledge, on the present and the future of the immersive spaces, as phenomena which facilitates and gives different ways to confront the media and education.

2. *Content of the publication*

The present issue of ICONO14 is composed by thirteen articles, divided by theme into three clear blocks, and an audiovisual product, comprising the interviews done in the headquarters of Ciberbabia and Second Life to two professionals on the business fields and research on 3D environment, such as Aito Morras and Fernando Pascual, who offer for this monographic issue their experiences on the different business models done up to today in these environments, as well as their vision on the communicative and educational possibilities in these spaces.

Regarding the articles, the first block is composed by the contributions, which focuses on the use, application and experiences related to the virtual reality on university education, and the context defined by the European Higher Education System.

The issue starts with the reflection of Alfronso Cuadrado, *Utopia and Dystopia of the digital media for education.* A trip through the collective imaginary to show the dichotomous debate, in whose origins underlies the myths of the birth of the virtual reality and its use as an educative tool. An analysis is done on the human behaviour against the unknown, the fear to all that the magical or diabolically the physical reality can reproduce or replace. A constant throughout the history confronts the innovative spirit and only the empirical verification of the benefits can help to overcome the initial reluctances.

Regarding the use of 3D environments and its implementation in the context of Higher Education, José Antonio Jerónimo, Lidia del Carmen Andrade and Ascensión Robles stress the training of teachers i n Higher Education and the importance of the design of the educative system as to generate the immersive educative environments. In the *Educative design of the virtual worlds,* the authors present an experience that shows the educative potential of the metaverses in university education.

E-learning in 3D virtual worlds presents the experience developed by Teresa C. Rodríguez and Miguel Baños in their teaching labour on the practice of learning activities in virtual environments, such as Second Life, in the university teaching, trying to show the immersive possibilities of these spaces and their implications in the communicative process among the teacher and the student.

Djamil Tony Kahale analyses the Interactive and immersive features of the so-called virtual rooms, in the context of Higher Education, with a practical case in the use and the application of these environments in the learning-teaching process of Law. In *Virtual Rooms.Tools in the university distance learning,* the author underlines the needed training of the teachers to explore and exploit the communicative possibilities in the use of virtual room in higher education.

Metaverses and Education: Second Life as an educational platform, shows a critical analysis of the use of metaverses as immersive educational environments, framed around the concept of e-learning 2.0. Israel V. Márquez offers to us his experience on metaverses in general, and in Second Life in particular, sharing what the author call advantages and disadvantages in these environments as educational platforms.

In *Social Educative videogames in the classroom,* Carina González and Francisco Blanco present a prototype of cooperative educational videogame, with which they arise the social component of the educational videogames, as a decisive factor in the training for cooperative work.

Esther Monterroso y Raquel Escutia defends the use of metaverses in Higher Education, in the Law field, pointing out the possibilities of recreating the reality and virtual experimenting, through the assumption of different roles. In *Immersive Education: practical teaching of Law in 3D,* the authors reveal the interesting potential of the 3D environments as to experiment the study films linked to the Social and Law sciences.

In the second block of this monographic issue there can be found contributions on the different components which make the virtual worlds the perfect environments to be immersed and to develop the educommunicative processes.

David Maniega, Pau Yánez and Pablo Lara present anexperience in which two sides of the immersive learning converge. On the one hand the linguistic immersion and on the other side the immersive education through the use of online videogame with 3D technology, as such is the case of the Spanish teaching “Lost in La Mancha” videogame proj ect developed

The immersive virtual reality in intelligent environments of learning focuses on the new interactive devices which allows the sensorial feedback and favours the immersion in the environment. Alma Gónzalez and Gerardo Chávez stress the importance of the feedback as personalized element in the virtual reality.

Basilio Pueo y Manuel Sánchez-Cid do an exhaustiveanalysis of one of the most fundamental elements for immersion for adults in 3D, such as surrounding sound, deepening in the importance of the auditory component in the immersive act. In *The surrounding sound in immersive audiovisual environments, suggested from the educational sphere,* the authors do a retrospective of the surrounding or immersive sound systems.

The third block is composed of those articles referring to the development of the 3D environments in the museology field.

Antonio Otero and Julián Flores do a reflection onthe features of virtual reality as a communicative way. *Virtual Reality: A mean of communicating contents,* reflects the different possibilities in the virtual reality as an educative tool in non-formal educative contexts such as the museums.

In *Magnified Reality, education and museums,* David Ruiz presents the educative alternatives of the magnifies reality, through the analysis of specific projects applied in the classroom and developed in Spain, such as “Aprendra” [1], o the so called “Big-Bang 2.0” [2] within the Eskola 2.0 programme. The article Also reflects the reflections of the author regarding the use of magnified reality in museum and Interpretation centres.

To finish, an audiovisual product closes the issue. This product reflects the contributions done for this issue by Aitor Morras, president of Explor 3D[3] and co-founder of Virtual Mind, and Fernando Pascual (TeKnoArtia), Solution Provider of Second life, and expert in the development and services for immersive environments. Such contributions were done during the interviews that took place in the headquarters of Ciberbabia in Second Life, and in these interviews, they offer their point of view, from their management experience and their research work on the business models that these spaces allow to develop, the potentiality of these environments for the development of initiatives linked to learning and knowledge processes, and its perception on the future challenges of these environments.

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[1] Project developed by the Multimedia and Graphics Group of the Ai2 Institute and the l'Escola d'Estiu - Universidad Politécnica de Valencia, together with the Technological Toy Institute (AIJU) in Ibi (Alicante) as to evaluate the possibilities that the Magnified Reality offers as to improve the learning process.

[2] System developed by the company Virtualware for the Education, University and Research Department of the Basque Government within the Eskola 2.0 programme, through the use of different digital formats (2D animation, virtual reality, magnified reality, Google Earth, etc.).

[3] Metaverse, Videogrames, Virtual worlds and Virtual reality Observatory [www.explor3d.org].

Towards a sustainable model of Second Life (SL) development

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Background

The University of East London (UEL)'s school of Health, Sport and Bioscience has created a multi-disciplinary polyclinic in Second Life (SL) for use by herbal medicine, physiotherapy and podiatry students. Each discipline has its own area consisting of an outpatient clinic (herbal medicine and podiatry) or hospital ward (physiotherapy) where students interact via their avatars with virtual patients and related objects e.g. Xrays, test results and patient notes to develop their clinical reasoning skills.

Regardless of their innovative nature and potential to transform the learning experience, there are many barriers to effective use of SL and virtual worlds. SL in fact is littered with developments that have fallen into disuse for reasons including: lack of computer infrastructure for staff and students to use SL; lack of expertise for ongoing maintenance; dependency on one particular member of staff who has lost interest or left the institution; more recently, costs of land in SL; inappropriate choice of virtual worlds for activities that could be done more easily on other platforms. In other words, SL and virtual worlds generally are demanding and challenging environments and use of them in learning (and perhaps other areas) needs to be justified in ways that would not be necessary in other contexts (Warburton 2009).

Having experienced some of these problems in our early experimentation with SL, we were determined to take a more considered approach to the polyclinic and the virtual patients within it. The cost justification was straightforward enough in that we already had a region on SL and were likely to be able to pay for it for several years. We had also secured learning and teaching grants to create the polyclinic and associated infrastructure. We could also justify the development educationally as the ability to simulate clinical situations for healthcare students is already a well established application of virtual worlds (de Freitas 2008; Kirriemuir 2008; Beard et al. 2009).

Having made our case to use SL in the first place, the ongoing development has been strongly focused on sustainability, the main characteristics of which are: a multi-disciplinary approach to avoid the problem of the single enthusiast and guarantee a critical mass of users; a front end editor whereby the academic or non-expert user can add and maintain many aspects of the patient cases; a virtual patient model that is adaptable to different contexts and disciplines; patient cases that can be reused ad infinitum by future students with minimal intervention; an external database to house the case data, so giving the option to use virtual worlds other than SL in future. Additionally we are open to partnerships with other institutions and are currently involved in a collaborative venture in the podiatry area. Alongside all the development effort, students receive full inductions and their experiences have been subject to regular evaluation to ensure provision is appropriate, relevant and rewarding.

Figure 1 below provides an overview of the key processes and relative responsibilities of the SL developer, the academic non-expert and the SL expert user who falls somewhere between the two. The diagram highlights how the heavy dependence on the developer at the outset and whenever new patient cases are added gradually reduces in the revision phase when the patients are fully operational and only need minor changes.

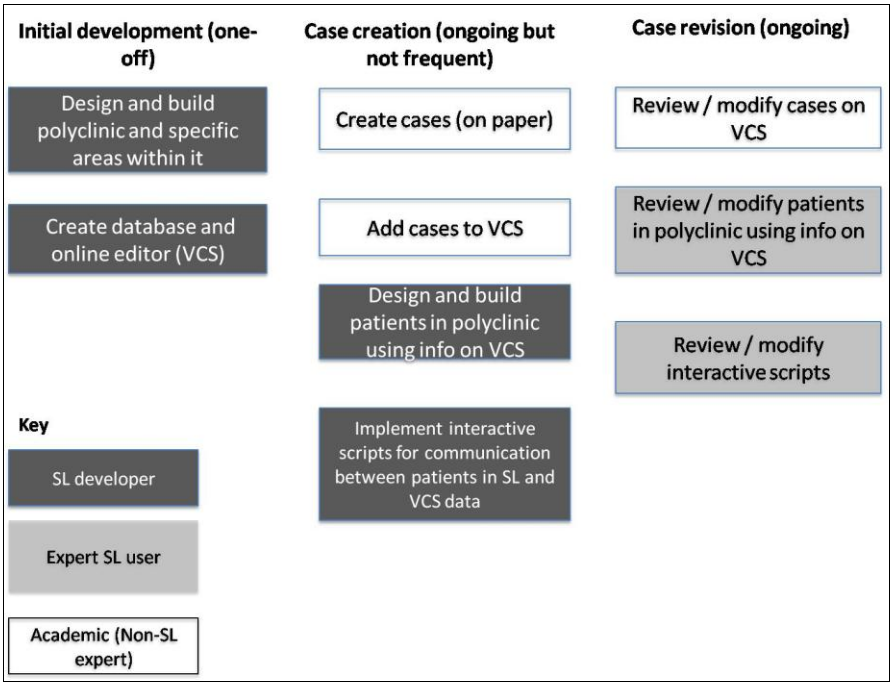

Figure 1 - Roles and processes in development of virtual patients for use in Second Life

In spite of this approach, however, there are ongoing challenges most notably:

- Optimising the design of the VCS editor interface to prompt staff to define all the elements of the patient case, in particular the choice of keywords to trigger meaningful responses from the patient in conversation with avatars
- Ongoing reliance on an expert user, if not developer, to do the SL facing work that cannot be entirely editor/database driven (for instance, automatic data update between VCS and SL in terms of patients' appearance and equipment in the bay is not currently possible without SL developer involvement)
- Creating patient cases for use in this way is time consuming for academics regardless of the technicalities of implementing
- Majority of staff and students are not familiar with this type of environment and need time to master it meaning that many do not take full advantage of it because of time pressures in other areas of their study/work

This demo will show how student avatars interact with the patients in the SL polyclinic, and at how the academic (non-expert SL user) can contribute to the process of adding and maintaining patient cases via the VCS editor interface. It will also cover our ongoing efforts to increase the efficiency of the processes involved in development as well as the effectiveness of the associated learning activities.

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Quest History Demo

Jonathan Himoff
Rezzable Productions

Abstract. Quest History is a new in-classroom 3D, immersive education resource for teachers to present learning content on whiteboards or large monitors to students and then for students to undertake related immersive activities on their own or in small groups. The demo will show the first version of the product which focuses on Ancient Egypt and King Tut.

Keywords. 3D, Immersive, Online, Game-based Learning, History, Geography, Egypt, Whiteboard, Teacher, Student, Demo, Classroom, Web-social

Introduction

Quest History is an exciting new product designed to give teachers interactive, highly visual and engaging education content to present to and explore with their students. Students immediately react positively to the game-like, immersive experiences and are eager to discover details about the educational scenes as they complete their Quest objectives.

There is a fun, challenging context where students imagine that they are in the near future where people have lost interest in studying the past. They must become certified time travelers in order to go back into history and collect their own primary data and experiences and bring it back to the main Discovery Lab. The demonstration will show the Teacher presentation, the Student Quests and the web-based Student Notebooks that are created as part of the learning experience.

1. Teachers Lead the Class

The Quest History system gives Teachers complete flexibility on how they want to use the resources. Teachers can customize their selection and sequencing of the points of interest (POIs) that they would like to use for a specific class into their Itinerary. The system also contains suggestions for Lesson Plans as well as detailed information about each POI. Further, Teachers can create their own Lesson Plans and then share these within their School or across the Quest History Teacher community.

The User Interface is designed for interactive whiteboards and is simple to use featuring clear buttons to advance along a pre-selected Itinerary. The Teacher section takes place inside the Discovery Lab which features an array of 3D content including maps, flyovers, walk-throughs, story-tellers and photo-realistic objects. It delivers stunning classroom resources that are more stimulating and exciting than photos or video can be.

Teachers also have full control over members of their class. They can add and delete students and other Teachers as needed.

Figure 1. Teachers lead tours across the Discovery Lab to present a range of points of interest

2. Students Take Their Own Quests

Teachers can allow Students to access specific Quests as they think works best. Each Quest starts with a mission briefing and then drops the Student into a visually rich and exciting environment to solve challenges. At the end of the Quest there is a short review of key information and activities. We will show a selection of Students Quests including Mummification, Hunting, Tomb Exploration and a character-based simulation of Daily Life in Ancient Egypt.

Figure 2. Students go off on their own, or in small groups, to take on Quest challenges

3. Web-Based Notebook Pulls It All Together

Students can collect objects from the Quests and Teachers can send objects from Discovery Lab session into the Student's personal notebook. Further, as Students gain points they can customize their Notebook by changing colors and adding badges. This Notebook can then be shared with their Parents.

The Notebook is a place where Students can add their own comments and Teachers can assign writing activities.

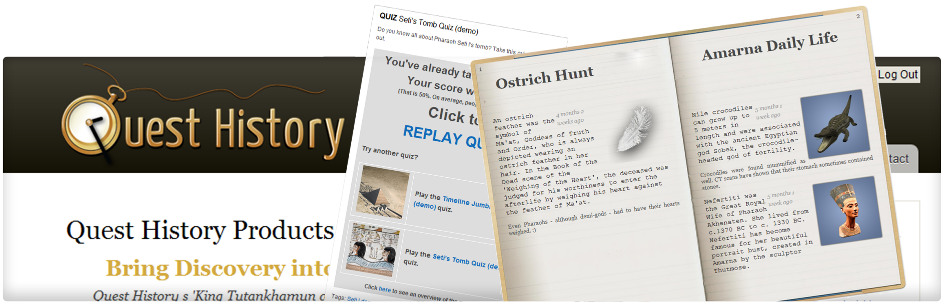

Figure 3. A set of web-based resources for Teachers and Students

4. Improved Student Results

Quest History combines the best of 3D online plus interactive plus web social to get and maintain student attention. Students will learn and retain educational content as well as improve analytical and critical thinking skills. There is a class activity stream and points leaderboard to encourage interest by means of positive competition. Teachers can deploy Quest History in a very flexible manner to allow them to maximize benefit for their classes.

ST.ART Project Demo

Jonathan Himoff
Rezzable Productions

Abstract. ST.ART project is a collaborative, immersive education resource for teachers and students focus on techniques, history and social impact of street art. Students learn through collaborative online 3D activities. The demo will show a short machinima video that gives a tour of the city center and all the activities that you can do. Followed by a real time 3D virtual demonstration showing multi-user and collaboration. We will also review the technology platform and discuss strengths and weaknesses of the OpenSim platform. ST.ART has been developed over 18 months by a group of eight schools across five countries and funded by the EU.

Keywords. 3D, Immersive, game-based learning, arts, street-art, classroom, EU, open-sim, virtual, avatar, opensim, drupal

Introduction

ST.ART is the acronym of STreet ARTists in a virtual space. The ST.ART project is designed to give students freedom to create in a virtual environment and take responsibility from their actions. The specific objective of the ST.ART project is to help young people acquire the basic life-skills and competences necessary for their personal development, for future employment and for active European citizenship.

The main aim of this project is to get to know the difference between aesthetic and street art forms, graffiti and vandalism, and how different choices can lead to different consequences. The project aims at encouraging wider arts participation, creative teaching and learning through a new integrated methodology that combines Web 2.0 and OpenSim. This new kind of platforms integration creates a Virtual Learning Environment (VLE) that aims at developing an innovative learning environment.

1. Learning through a game-based environment

Combining young people's fascination with the Internet and web 2.0 with teaching about street art forms and vandalism is the inspiration behind the project. Most people do not like graffiti 'tagging' , but 'street art' is highly valued. Street art is art created in public places, and it includes murals, graffiti, stencil art, sticker art, poster art, performance art, art cars, and street installations.

Students are able to customize their avatars and then earn rights to change the ST.ART metropolis virtual environment. There are also reserved areas for gallery shows and teaching spaces.

In this project art forms and art education are used as a bridge to re-establish communication between young people and local community and to strengthen the sense of common ground and interest. In this context the students will be run to develop their creativity in a correct and legal way. In this environment , students have the full control over their actions. Through a badging system, students get their rights as stencil painter, painter or as a street artist. The mayor that controls the city main rules set rules accordingly and student learn how to follow rules and respect others.

2. Short and Long Term Objectives

- The ST.ART project is an education curriculum about street art forms addressed 16 to 18 year students in secondary school, especially in art schools.
- The specific objective of the project is to help young people acquire the basic life-skills and competences necessary for their personal development, for future employment and for active European citizenship. The main aim of this project is to get to know the difference between aesthetic and street art forms, graffiti and vandalism, and how different choices can lead to different consequences.
- Raising young students' awareness on street art forms as opposed to vandalism;
- Combine their interest for the Internet and the web 2.0 technology with learning;
- Raise awareness on their conscience as European citizens.

Figure 1. Avatar painting with a spray can

3. Technology Platform Results

We will also present an overivew on the key technology components OpenSim, Drupal and Skype and review their strengths and weaknesses in this project. While OpenSim was a good experimental platform it is not adequate for larger scale deployment.

Feel it! Do it! Share it! Findings on experiential and collaborative learning in a virtual world

Esko Lius, MA
Digital Communications Manager

In this demonstration session two cases are examined. One is an example of experiential learning in which the learning is built on the interaction of the learner's avatar and the environment. The other is about collaborative and simultaneous interaction of inworld residents.

The demo session "Feel it! Do it! Share it! Findings on experiential and collaborative learning in a virtual world" will disclose how the youth learn European literary history better on an adventurous experiential learning path than from a text book, and demonstrate how collaborative methods linked in acting in the virtual space work among adult students.

Background

The learner's experience in a learning environment situated in a virtual world differs fundamentally from the use of other online learning environments. One of the most essential differences is that the flow of information is much broader. On an ordinary online learning platform the environment itself is static and abstract, and the only variable is the data related to the subject. In the virtual world, the environment itself is a variable to be dealt with. Moreover, not only is the constructed virtual environment dynamic, but also the interaction between participants of the learning process moulds the overall course of events.

The perception of the virtual world environment and the learner's avatar in it resembles the socio-spatial experience in the physical world. That forms a virtual representation of him- or herself in the context of the learning environment.

Learning, in the sense John Dewey saw it, is rooted in experience, which is always contextual or environmental. (Heiphetz&Woodill, 13) The particular reason to choose virtual worlds as the learning environment lies right in the possibility to enhance and steer the learning experience by preparing the socio-spatial environment.

In this demonstration session two cases are examined. One is an example of experiential learning in which the learning is built on the interaction of the learner's avatar and the constructed environment. The other is about using collaborative learning methods and letting inworld residents to build their own agenda and knowledge.

Modus operandi

The demonstration will focus on two learning cases in the Second Life. The speaker will enter the virtual world (a broadband connection needed), and visit the environments presented. The take on the subject is practical, and the audience is encouraged to pose questions and to discuss.

Cases

European literary history learning path

Sotunki Distance Learning Centre in Finland put up an experiential virtual learning pathway on European literary history for second level school students. The virtual worlds expert Esko Lius and Literature teacher Heidi Heikkilä designed the virtual course to be an activating and hooking experience. For that, the various locations that represent different literary epochs, are made to resemble those era, e.g. the Age of Enlightenment is taught on the island of Robinson Crusoe, and to learn the Romanticism the students visit a virtual crypt to meet the ghost of Julien Sorel from the novel *Le Rouge et le Noir*.

Lius and Heikkilä compared learning outcome between students studying in the virtual world and students studying the same things from a textbook. The findings show that the students using the experiential virtual learning environment invested more time for learning literature. They also felt they had a more personal relationship to the subject, and they interacted more with each other. There was a slight difference in favour of the virtual worlds students in the learning outcome when the course ended, but after a while, the distinction got bigger. To put it short, the experiential learners remembered the subject better and longer.

Socio-constructivist collaborative learning

Studying 'collaborative learning' as distance learning oftentimes yields mediocre results, because the learners do not utilise the very method they are studying. More often than not, it is based on exchanging static, written texts. This kind of a procedure leaves also experiantiality out of the process.

The use of a virtual world as a socio-constructivist learning environment gives room for a multitude of ways of interaction: written documents, chat, multi-user chat, voice, gestures, postures, positions, doing things etc. The emphasis on interaction in collaborative learning makes it possible to enter virtually any space, even an empty sandbox. The examples from a course held in autumn 2011 show how the roles and ownership of knowledge shift from the one that learners have gotten used to in realworld learning environments.

The demo session will show how educators took part on a course on collaborative learning in virtual worlds, how they were introduced to work together in the virtual world, and how they formed collaborative teams in order to produce their own learning content and knowledge of the subject in a collaborative process.

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A Method for Microanalysing the Acquisition of Knowledge during Virtual Experience

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Abstract. It is now more than a generation since one of the founding fathers of modern educational theory, Robert M. Gagné, identified a strategic problem with what was then called Computer-Managed Instruction. His problem was "how to identify and sequence content for intellectual skills" (Gagné and Dick, 1983, p289), and it has plagued educational initiatives ever since, making it difficult for providers of today's immersive education systems to prove the cost-effectiveness of their products to a cautious marketplace. The problem, ultimately, is that there is no established model of human cognition capable of recording the moment-by-moment arrival of the component fragments of a learning experience. This demonstration will report progress with the *Konrad* cognitive simulation software (Smith, 2010), a system which uses large database design principles to produce hard copy print-out containing exactly this missing datastream. Specimen output will be provided.

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Workshops

Open Wonderland In-World Panel

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Abstract. Remote from Boston in the US, Nicole Yankelovich will take the audience on a virtual tour of an Open Wonderland world. She has invited members of the open source community to gather in-world to talk briefly about their projects. Many will also demonstrate features they have created or show off worlds they have built.

Keywords. Open Wonderland, virtual tour, virtual worlds, open source.

Hands-On Workshop: Learn to Build an Open Wonderland World

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Abstract. In this two-hour hands-on world building session, we will start by reviewing a range of Open Wonderland features. For the bulk of the session, we will focus on building a virtual space from scratch. By the end of the session, attendees will be able to add content to the world including graphics, video, slide shows, 3D models, and shared application, arrange that content, and add "capabilities" such as audio, tooltips, clickable links, security, and a variety of others.

Keywords. Open Wonderland, 3D virtual worlds.